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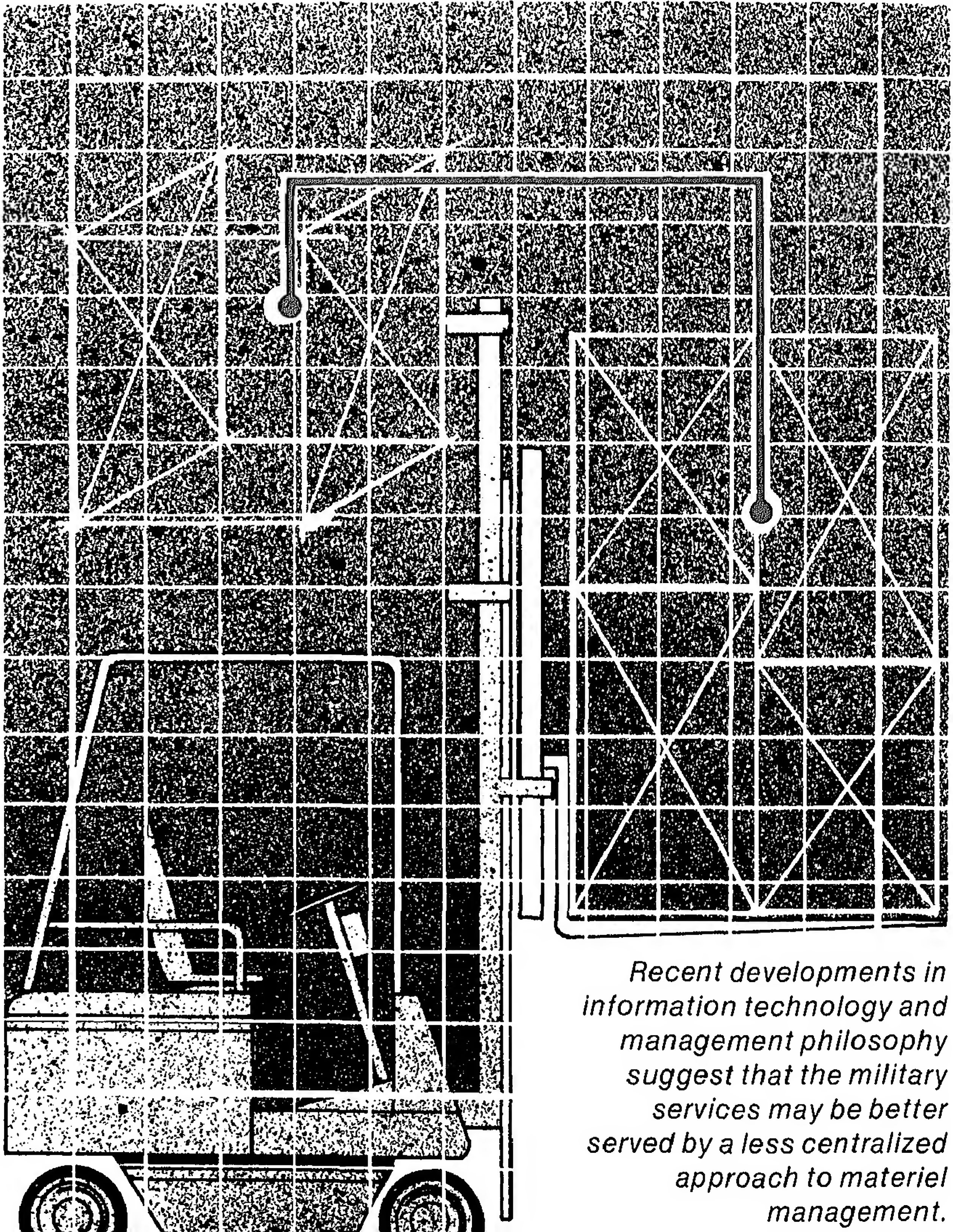

Recent developments in information technology and management philosophy suggest that the military services may be better served by a less centralized approach to materiel management.

A proposed materiel management organization for DoD National Inventory Control Points

By CAPTAIN ANDREW J. OGAN, USAF
and
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In the earliest military organizations, logistics was a fairly unstructured discipline. Individual warriors foraged for their food, provided their own weapons, pillaged and plundered for their pay, and were more or less responsible for their own maintenance.

As military organizations became more highly organized and centrally controlled, the various aspects of troop support became more specialized. The Quartermaster Corps and the Navy Supply Corps, even in Revolutionary times, were typified by a functional approach to the various disciplines required for total logistics support. Engineers, carpenters, cooks—even mule-skinners—had their specialties. Each specialty took pride in its unique skills and went to some lengths to define the boundaries of its responsibility and authority. As in the medieval guild system, individual specialties evolved a complex of training requirements, examinations, and levels of experience to qualify new entrants into a functional area.

The military services and the Defense Logistics Agency of today have, for the most part, inherited this functional approach to logistics support. Hence, one witnesses the phenomenon of supply people, maintenance people, acquisition management people, quality assurance specialists, and so on. This structure has served the military customer well over the years, delivering more tons of materiel per fighting man to the battlefield than also inherent in the traditional functional organization are some long-standing and well-recognized communications and behavioral problems which this paper will attempt to identify and address.

Information technologies and management concepts developed in recent years suggest that alternate organizational approaches may be effective in dealing with some long-term problems of logistics management. Civilian industry and, to some extent, the military services have been moving toward materiel management organizations to better coordinate the whole spectrum of logistics functions. In broad terms, materiel management is a concept that combines in one unit all specialties required for total logistics support, generally under decentralized management and specifically organized to optimize the overall goals of the organization.

The purpose of this article is to suggest a possible organizational structure or model national inventory control point for adapting the materiel management concept to the military services. In doing so, the paper highlights some problems inherent in current logistics organizations, as well as some anticipated benefits of the suggested NICP model.

Current NICP organization

point is that part of an organization responsible for requirements determination, acquisition, distribution, and technical services relative to a designated range of commodities or components.

The typical NICP is functionally aligned, that is, divided into several major operating entities, each contributing to the overall mission. Although other elements such as manufacturing, maintenance, or warehousing may be collocated, the functional elements of the NICP itself usually consist of a supply unit, an acquisition unit, and a technical unit. Though the specific structures and titles within individual elements may vary, functional areas tend to be subdivided along commodity lines, with a management information system supporting this substructure.

In theory, the sum of all of the logistics disciplines equals a total support package for the organization. In actual practice, it is the rare (and well-funded) organization that doesn't have at least a little disharmony among functional areas in logistics support. The following accusations are typical. Maintenance people claim they could do a much better job if they had the proper parts. Supply maintains that it could provide better support if maintenance would forecast properly. Acquisition managers say they need earlier and less flexible requirements from supply in order to deal effectively with contractors; and, according to technical and engineering people, they could pvide accurate data if the operations and des people would quit changing the hardware.

Implicit in such functionally oriented co plaints are two messages. First, all the me necessary to complete the logistics job are available to any one functional element; second "completed" job within many portions of logistics structure occurs not when the custor gets his part but when a properly completed pi of paper leaves one functional area headed another. To some extent, these and similar pr lems of goal congruency and communication b riers between the various logistics disciplines present in the current structure of all milit NICPs. Some understanding of them is necess as a frame of reference for the materiel mana ment organizational proposal which follows.

Goal congruency. In order to overcome the fluence of conflicting factors outside its contr each functional area in a typical NICP appears have developed objectives designed to measure function somewhat independently of the ot disciplines. For example, supply may have a tain customer "fill rate" as its primary goal minimizing aging backorders as a secondary g Acquisition may have as its primary goa

designated number of contracts awarded and may give second priority to minimizing administrative lead time. The two sets of goals may only appear to be mutually reinforcing. In actual practice, any pressure or priority supply may put on improving fill rate may only detract from acquisition's goal of reducing administrative lead time. If each element tries to force the other to divert resources to satisfy a particular goal, organizational conflict results.

Other factors compound the problem. While a supply element's responsibilities normally include customer support (measured in terms of supply availability), it controls only a portion of the means necessary to provide that support. Ancillary roles, such as determining item adequacy and actually acquiring the assets, are the responsibility of the technical and acquisition elements. Routinely, the system may work well. However, since these ancillary elements are neither responsible for, nor are their goals measured in terms of, customer support, whenever exceptions arise, the priority which that exception receives within each functional area may have more to do with internal goals and objectives than with customer support.

Because the logistics support process requires lateral coordination, and because conflicting objectives ... competition for resources, a complex internal communication system often develops. In that system, the isolation of functional prerogatives may play at least as important a role as does customer support. Viewed in terms of functional goals, a bread-and-butter status request from supply is a disruptive annoyance to the acquisition element, because it requires use of acquisition resources without contributing to internal acquisition objectives.

Under these conditions, it is perfectly possible for each area to be attaining most of its functional goals, while the customer still has not received adequate support.

Communication barriers. Within any organization, conflicting goals can easily lead to the formation of communication barriers between functional elements. Each area may well tend to view input in terms of its own needs, interests, and goals. To protect and insulate each function from the demands of others, the communication process often becomes more formalized. Using the Contracting and Production Directorate and the Supply Directorate at a typical Defense Supply Center of the Defense Logistics Agency, Figure 1 (p. 6) charts the communication process for a status report on a requisition. The follow-up is only one of

while Contracting and Production must allocate its limited resources to respond.

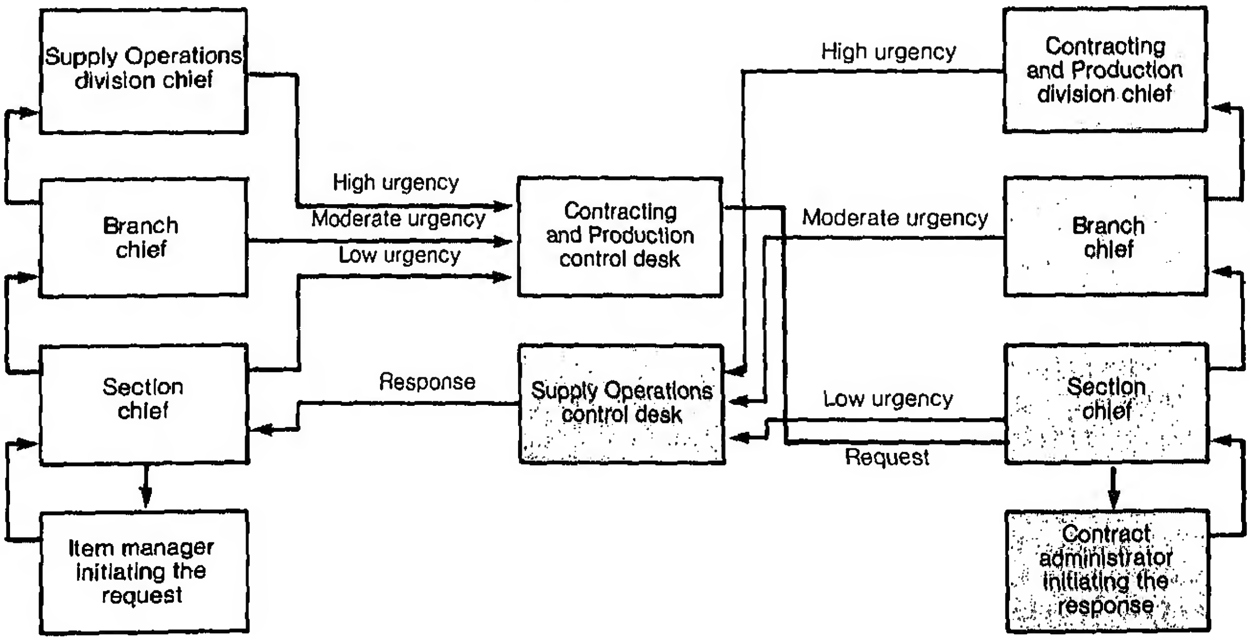
Within the existing organizational structure, resolution of such conflicts takes the form of increasing the number of management levels involved in direct proportion to the urgency of the requirement. The more urgent the requirement, the more extended the communication channels become. If the request is routine, the item manager must justify his request through two or three levels of management, and the contract administrator must reply through corresponding levels within his directorate.

These communication barriers appear to be the result of efforts to maximize individual rather than collective goals. If such barriers do in fact develop and are effective in furthering the parochial interests of the functions involved, the overall objectives and goals of logistics organizations may suffer.

Resolving functional conflicts. Whatever problems of goal congruency or communication barriers may exist within the logistics system, the fact is that all functional elements must interrelate. To deal with functional conflicts at the working level, managers have developed and implemented vari-

Figure 1. Communication barriers between functional elements at a Defense Supply Center

Within any organization, the communication process is often formalized to insulate one function and its goals from the demands of others. This figure shows how a request for a status report on a requisition would be routed through various levels of management; the more urgent the request, the more layers of management that become involved in review and approval.



and integrate efforts toward overall goal achievement. These working group arrangements take many forms, from ad hoc groups which integrate collateral functions to elaborate committee and subcommittee systems which integrate the functions of several elements. Although such measures may succeed on a local scale, they represent circumvention of the formal organizational structure. Whenever mission accomplishment depends on, or is enhanced by, circumvention of the formal organizational structure, the time has come to examine that structure for possible change.

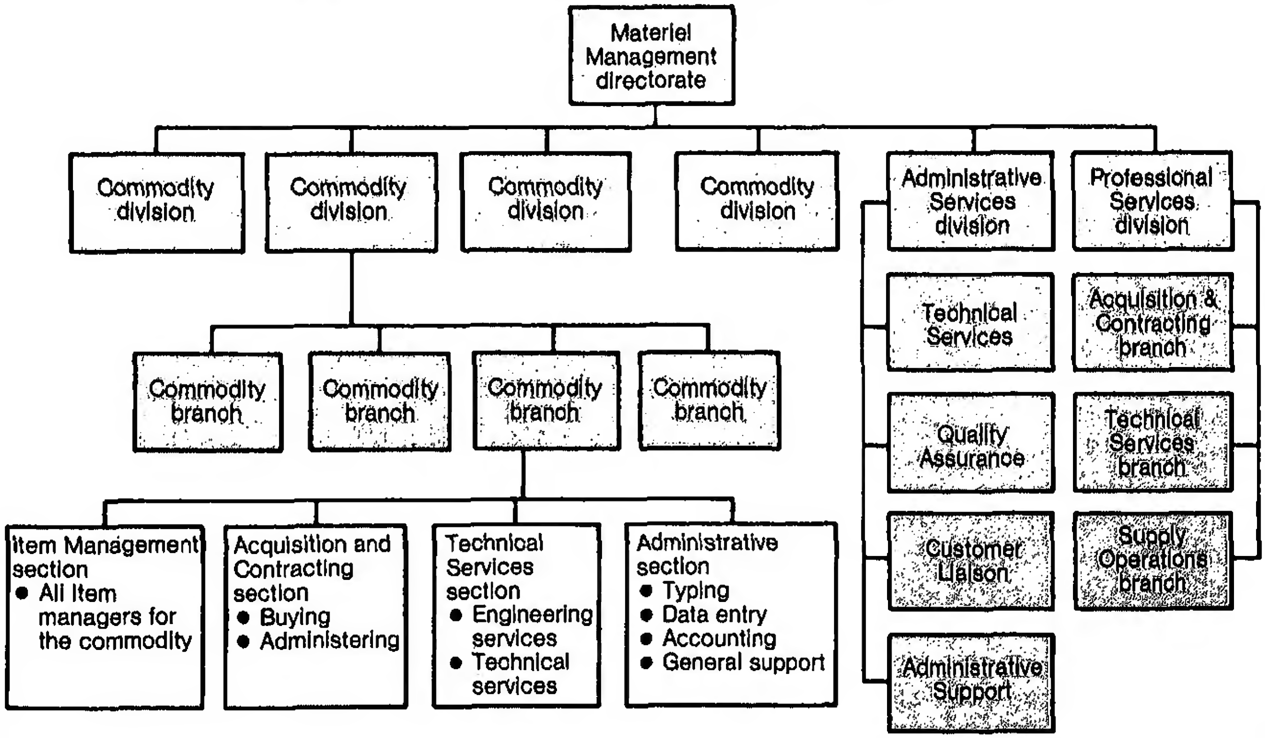
Materiel management structure

If logistics functional elements are pursuing individual goals in relative isolation from one another, an alternative is to organize along mission management organization for Department of Defense National Inventory Control Points can link responsibility and authority at the lowest practical level, thereby fostering goal congruency and eliminating many communications problems. To be effective, such a restructuring would have to include acquisition, supply, and technical or engineering elements, since they all directly impact on customer support.

For a typical DoD NICP, a materiel management model might resemble the structure depicted in Figure 2. Organized under a materiel management concept, the proposed commodity management model operates on the basis of a classic matrix structure. Managing each commodity as a unit or product line gives each manager the tools and information he needs to provide complete customer support. In effect, this approach rotates

Figure 2. A proposed model for a DoD National Inventory Control Point

Under the authors' proposal, a commodity management model would be based on a classic matrix structure. Given all of the tools and information needed to provide complete customer support, each manager would manage an individual commodity as a unit or product line.



the lower tier of the typical organizational structure 90 degrees and segments it by commodity, so that supply, technical, and acquisition people work together under one supervisor per commodity group. As explained more fully below, the model proposes a materiel management directorate organized into several commodity management divisions and two support divisions.

The commodity divisions. Each commodity division would manage a broadly homogeneous class of items and would contain all organizational elements needed to manage those items, provided the organizational elements were compatible with a matrix structure. Each division would provide the complete range of logistics functions for the commodities it managed. Under the division would be commodity branches (see Figure 2). In order to provide total support to an assigned commodity group, each branch would include an item management section, an acquisition and contracting section, a technical services section, and an administrative section.

These branch elements are the key to this proposal because responsibility and authority for customer support are completely integrated at this level. Because he exercises virtually complete control over the commodities assigned, the commodity branch chief would be in a position to resolve conflicts and work-flow problems that cross functional lines. He would serve in a capacity similar to a product manager in a commercial firm, who is allotted a share of the budget and given a stock availability goal to achieve.

Assigned to each commodity manager's branch would be all the major elements required to achieve his performance goals. He would thus have both the responsibility and the authority for supply availability for all items assigned to his branch.

The support divisions. Two support divisions are best centralized. One would furnish professional services; the other, administrative.

The professional services division, which would give managerial support to both the director of materiel management and the commodity divisions, is critically important for two reasons. First, it collects and analyzes data relative to overall organizational performance and identifies such information to the materiel manager. Second, under a matrix management approach, it insures that legal, technical, and other functional requirements are uniformly and completely integrated across commodity division lines.

The administrative services division would handle general and administrative support functions not appropriate to the commodity divisions. Cataloging, quality assurance, and customer service are examples of the kinds of functions most economically managed by this unit.

Support divisions would also provide career paths for the development of functional specialists beyond the section level. Such paths are necessary so that personnel with senior-level staff ability can gain policymaking experience and advance to upper-echelon positions in management. Filling these positions with qualified, experienced personnel is critical to the continued good health of the system because they are the conduits through which functional guidance flows from national and headquarters staffs to the commodity managers in the National Inventory Control Point.

Matrix relationship. Figure 3 shows the basic flow of line and staff responsibilities in the matrix structure suggested; the line of demarcation between the two is fairly clear. Line management is responsible for achieving a certain level of customer support and integrating the logistics disciplines toward that end. Staff management is responsible for maintaining liaison with appropriate headquarters' functional elements and for insuring compliance with functional requirements throughout the materiel management structure.

Benefits

Moving people and aligning organizational units in order to implement this proposal would be dis-

NICP system, the question inevitably arises, "Is it worth it?" Realistically, reorganization on this scale can only be justified if it makes possible:

- Substantial savings in either manpower or inventory through increased productivity and effectiveness.
- Resolution or amelioration of significant organizational problems.

We believe that the materiel management model just described would result in job enrichment at the working level, which, along with direct lines of communication between functional elements, would substantially improve productivity. It offers an integrated system of congruent goals that, in conjunction with the removal of communication barriers, should positively influence effectiveness.

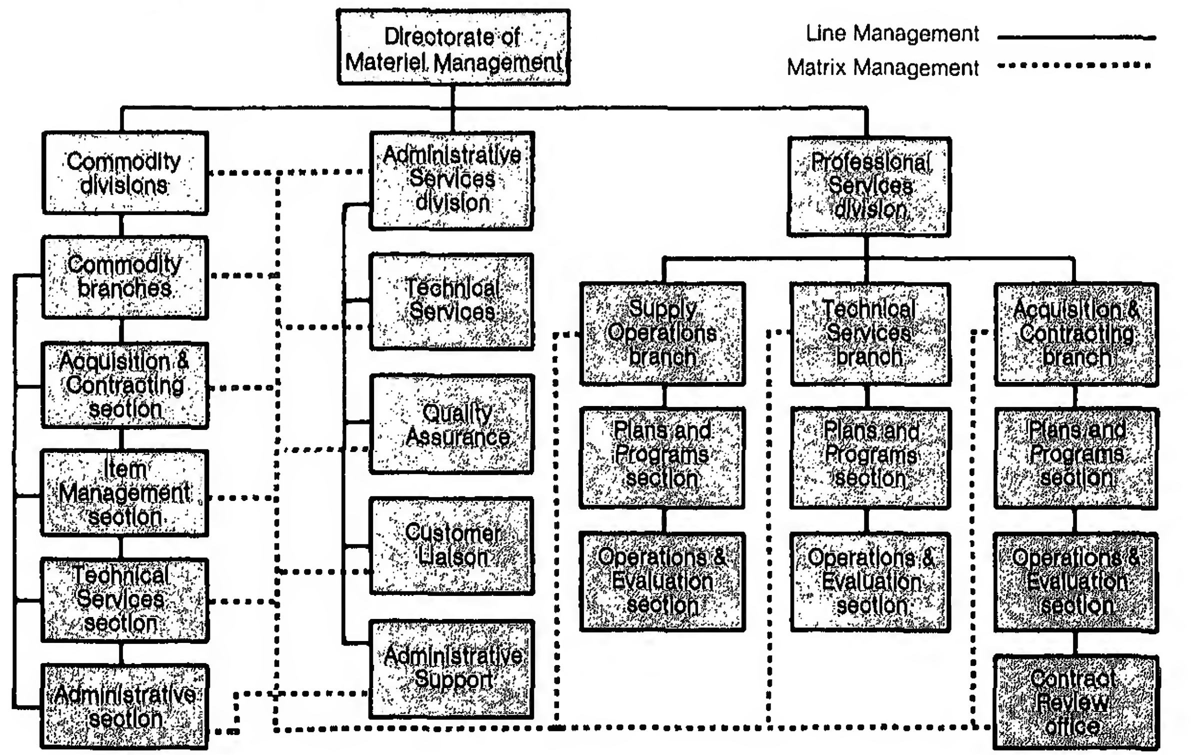
Test results tend to confirm these beliefs. For a year, beginning in August 1979, the Defense Control group in its commodity branch, which manages Federal Stock Class 4730, fittings and specialties, hose, pipe, and tube. A single individual supervised supply, procurement, and technical people in the test group, all of whom were collocated and involved in managing a portion of the 4730 stock class. Those in the control group continued to manage the remainder of the items in FSC 4730 under the usual organizational structure and procedures.

DCSC tracked the performance of the two groups and found that at the end of the year the test group had achieved a 0.45 percent per month increase in total supply availability. Though not statistically significant in itself, the test group's performance was 21 percent better than the control group's.

The two groups showed the most dramatic dif-

Figure 3. Line and staff responsibilities under matrix management

Under the proposed matrix structure, line managers in the Directorate of Materiel Management would integrate logistics disciplines to achieve satisfactory customer support. Staff managers would act as liaisons with headquarters' functional elements and would assure compliance with functional requirements.



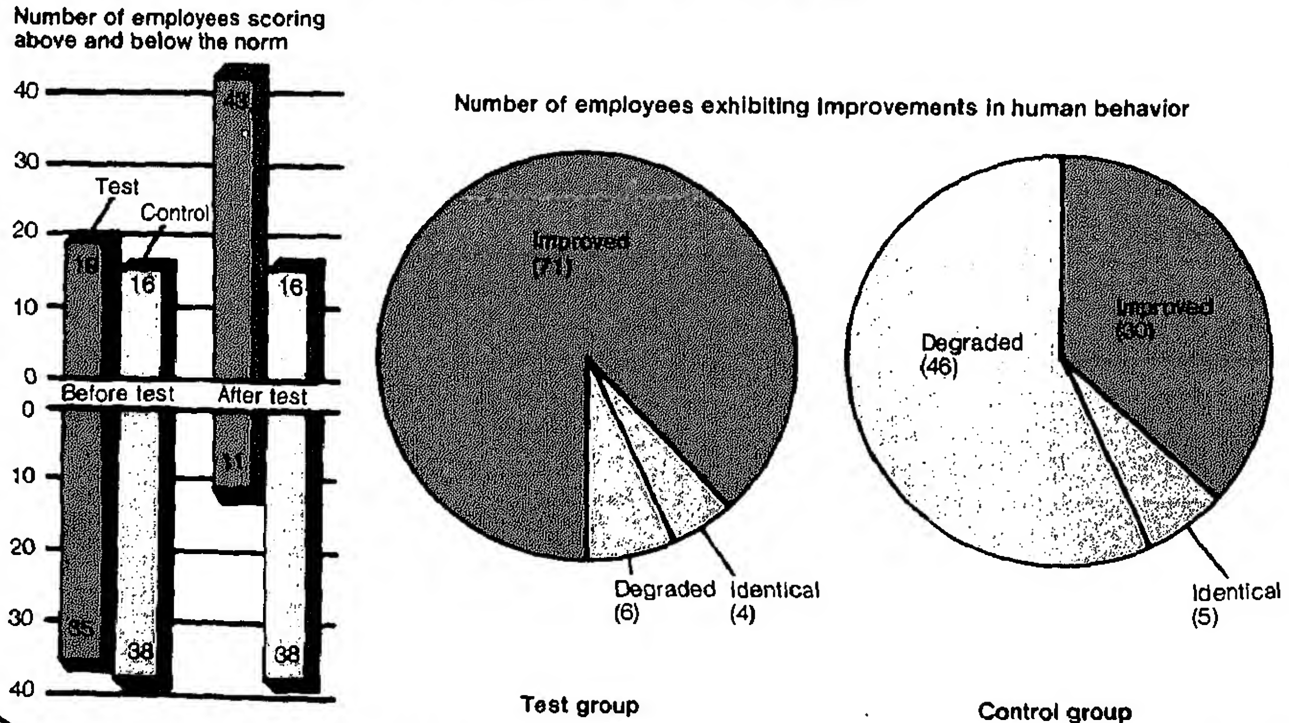
DCSC summarized the test results as follows: *In conclusion, the data and statistics gathered before and during the test indicate that overall the test group improved in those areas in which data was gathered and generally outperformed the various control groups. As the factors affecting the test were kept to a minimum, improvements with this magnitude and scope can only be attributed to the effects of the ICP Operations Management Concept.*

ferences in terms of human behavior (see Figure 4). Before the test started, at the midpoint, and again at the conclusion, both participated in a survey pertaining to organizational characteristics; group functioning; supervision; job characteristics; performance expectations; and individual characteristics, attitudes, and behavior. A national norm had been established for 54 of the 81 questions on the survey. Although the profiles for both groups relative to the norm were roughly the same before

A prominent feature of the materiel management structure being proposed is that it offers the kind of job enrichment available to the DCSC test group. A commodity branch manager, for example, would have not only a specific share of the budget and concrete goals to achieve, he would also directly control all the tools necessary to

Figure 4. Results of a limited test of the materiel management model

From August 1979 to August 1980, the Defense Construction Supply Center tested a limited version of the proposed materiel management model. Although the profiles pertaining to such human factors as group functioning and performance expectations were roughly the same at the beginning of the test for both the test and control groups as compared to a national norm, one year later those in the test group showed enormous improvement in their organizational performance.



ciency of NICP operations.

Enriched branch positions should be invaluable to the long-range health of the NICP since they would develop managers capable of taking on more complex tasks and responsibilities, thereby preparing them for senior-level positions. Job enrichment would also extend to those working in the sections—item managers and buyers, for example—who would have closer association with the other elements of the inventory management system and who would be able to see the impact of their own decisions on performance levels and customer support.

But job enrichment is only one benefit the proposed materiel management structure offers. It should also largely eliminate the problem of goal congruency between functional elements. As discussed earlier, in a traditionally structured NICP, lack of congruent goals can lead to workload imbalances and backlogs, as one function pursues its own standards at the expense of system optimization.

By assigning both responsibility and authority for system performance at the lowest practical level, the materiel management approach facilitates integration of the various functional elements of customer support. It directs the efforts of each element toward mission rather than functional goals, thereby enabling the branch manager to balance workloads among elements to achieve desired results. Improved goal congruency would also make it easier for upper management to direct organizational changes, because branch levels would be in a position to respond readily to such management initiatives.

Problems of implementation

The nature and extent of this proposed restructuring would present tremendous challenges to management. It would require extensive training to orient employees to new goals and revised organizational entities. Revised job standards and guidelines would be necessary, as would reclassification of certain positions. It would also call for changes to existing systems throughout the organization. data in a format suitable to the new organizational units. Realigning the financial management system along cost-center lines would avoid the adverse effects of competition for money between commodity branches. Also, many individuals might try to preserve their "territories" at the expense of the organization. Learning to work together would take time, and during this transitional phase, effectiveness might suffer.

However, senior-level logisticians also know that problems of interfunctional friction and competition for resources are real. They exist both because organizations are never perfect and because people who make up organizations want to do their best and thus compete for the limited means available to them. We believe that a materiel management structure for DoD national inventory control points offers one key to a possible solution to these problems because it directs the energy of the people and the structure of the organization toward a common goal of responsive customer support. Whatever the temporary difficulties during implementation, the long-term benefits of such a structure may make the solution well worthwhile.

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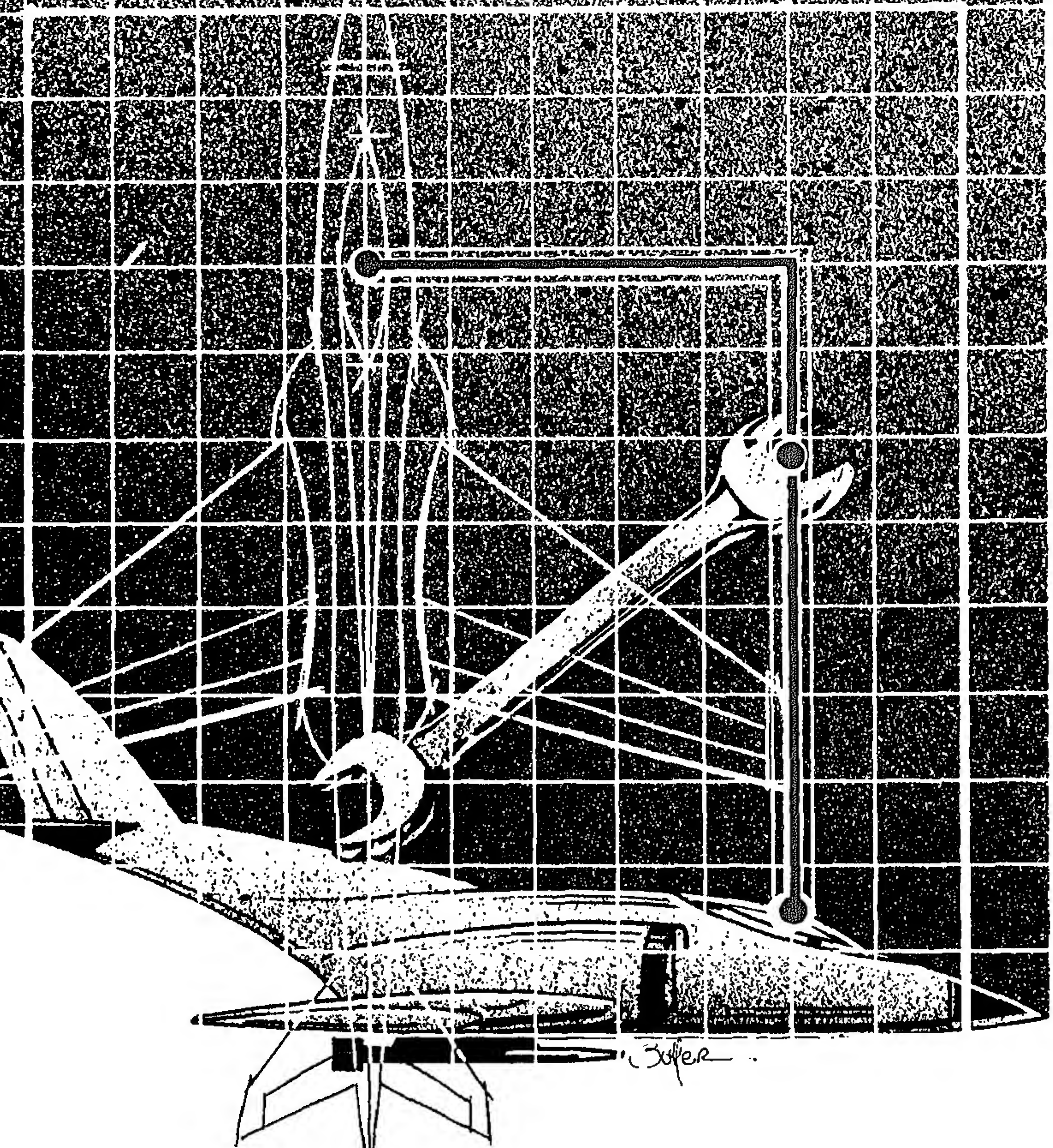


Research suggests that the approach of the commercial airlines to scheduled maintenance on aircraft systems is adaptable to Air Force ground communications-electronics equipment.

Toward more efficient maintenance: a reliability-centered approach

By LARRY J. GRAHAM

To maintain the safety and reliability of aircraft equipment at minimum cost, the commercial airlines (in conjunction with regulatory agencies and manufacturers) have developed a scheduled maintenance program for aircraft systems, power plants, and structures. The industry has documented increasingly sophisticated versions of this methodology, known as MSG-1, -2, and -3, after the sequential Maintenance Steering Group task forces of the Air Transport Association.

Prior to implementing this approach, the airlines (as required by the Federal Aviation Administration) inspected and overhauled aircraft equipment at fixed intervals, with little regard to the value or productivity of such activities. Under the MSG-1 and -2 programs, the airlines were able to categorize equipments with respect to their actual need for inspection and replacement and thus allow many items to "fly to failure" without adverse effect on schedule or safety.

Using MSG-2 methodology, coupled with an equipment condition monitoring program, the airlines were able to realize substantial cost savings in maintenance. These savings were significant enough that most large airlines extended the program from its initial application to widebody aircraft to their narrowbody fleets. After a decade of use, the airlines recently updated the MSG procedures and issued MSG-3.

The reliability-centered maintenance procedure under study by the Air Force is a slightly modified tenance of aircraft and corresponding improvements in aircraft availability. This article describes *how ARINC Research Corporation adapted com*mercial MSG-2 techniques for possible use with Air Force ground communications-electronics equipment.

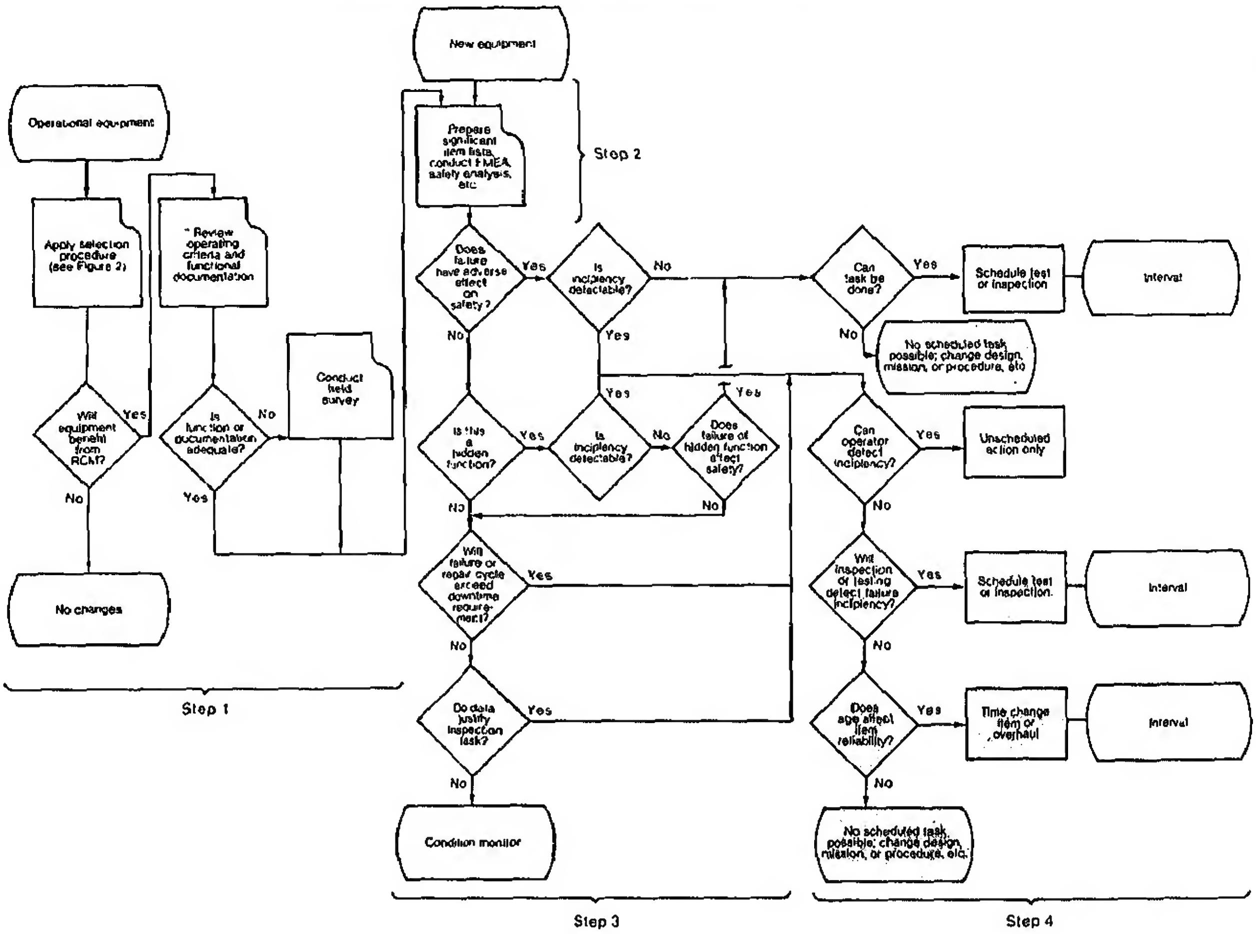
Program development

The objectives of an efficient maintenance program are to prevent a system's inherent reliability and safety from deteriorating and to do so at minimum practical cost. The purpose is not to correct deficiencies in inherent levels of equipment reliability and safety. Such problems require redesign of the equipment.

The specific goals of applying the reliability-centered maintenance methodology to ground communications-electronics equipment were to: analyze systematically the scheduled maintenance requirements for each equipment, justify objectively every maintenance requirement, and ensure that only justified maintenance actions would be performed. RCM methodology focuses scheduled maintenance planning on those equipments judged relatively important from the standpoint of safety or reliability.

In essence, the RCM methodology employs successive hardware analyses for purposes of identifying candidate systems and their significant items; identifying item functions, failure modes,

Figure 1. Procedure for selecting operational equipment for analysis



failure modes and effects. Figure 1 and the discussion below explain this process in greater detail.

Step 1: Preanalysis

Selecting operational equipment for analysis is a matter of applying the procedure illustrated in Figure 2 and then making a preliminary system evaluation. Based on that evaluation, analysts can determine whether the equipment selected is documented sufficiently to allow them to proceed to steps 2 and 3 of the RCM methodology. The

ficient documentation is not available, analysts do a field survey to gather additional information from maintenance personnel.

In addition to the knowledge of field maintenance personnel, information from operational and technical manuals and data from the Air Force Maintenance Data Collection System are available to describe system operation, functions, failure modes, major downtime contributors, and equipment condition. Analysts use the information collected during steps 2 and 3 to draw up a set of scheduled maintenance tasks, which is the final

for analysis in step 1. Analysts first prepare a list of *significant items—those equipments judged* important for reasons of safety or reliability—and then, for each item on this list, identify the functions, failure modes, and failure effects.

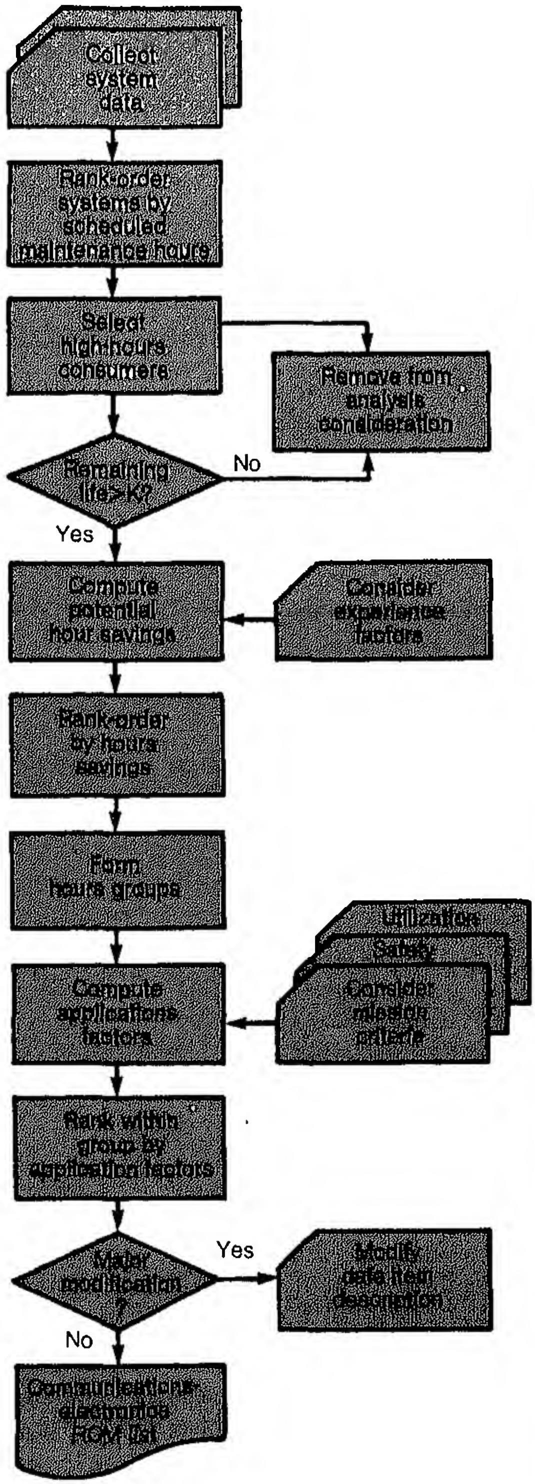
For new equipment, government contracts frequently require contractors to furnish fault-tree analyses, *failure modes and effects analyses, and* safety analyses as standard data items. If an integrated logistic support program is required by MIL-STD-1388, the logistic support analysis outputs are also applicable to this step. All these analyses directly support selection of significant items; *thus, a new equipment contractor can often* provide an RCM analysis at little additional cost.

Step 3—evaluation of the failure mode at both the system and significant-item levels—begins with the first four questions listed for that step in Figure 1. A positive response to any of the questions, which are asked *sequentially for each signif*icant-item functional failure mode and current inspection, is valid grounds for scheduling a maintenance task. The twice-asked question, "Is incipiency detectable?" determines whether incipient failures are detectable, either by an operator or an *inspection or test. The next two questions* relate, respectively, to the effect of hidden functions on safety and to what degree a scheduled maintenance task can assure that an item will be operational when required.

As the fourth and last step in the reliability-centered *maintenance process, analysts determine* which scheduled maintenance actions have potential for detecting and preventing system malfunctions and then establish inspection intervals. The three questions posed at this point all relate to maintenance policy. Can an operator, using normal instrumentation, monitor the equipment to identify deteriorating conditions likely to lead to failure? Can a maintenance task such as visual inspection, servicing, or testing be effective in detecting incipient conditions before undesirable system effects occur?

Finally, *can reliability* be controlled by periodically changing the item? Although many simple mechanical devices fall into this category, the reliability of complex electronic equipment is

RCM candidate equipment



usually cannot maintain the inherent reliability of such equipment; other actions, such as design, mission, and procedural changes, are the only means of achieving the desired reliability.

In establishing inspection task intervals for all items, the criterion is simply very low risk of failure or injury to the operator. However, if the proposed inspection task is unable to detect incipient failures or if the time between incipient and total failure is very short, the inspection task will be ineffective and realistic inspection intervals impossible.

A trial application

After developing a preliminary RCM methodology, researchers applied it on a trial basis to a solid-state instrument landing system AN/GRN-27(V), a meteorological radar set AN/FPS-77(V), and a gas turbine generator set veloped a set of five worksheets, which are used to:

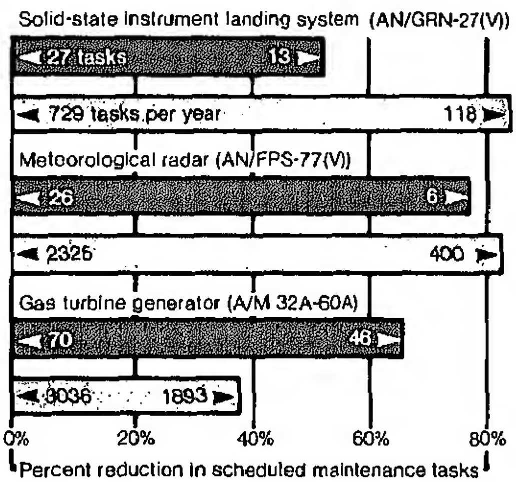
- Identify significant items.
- Conduct failure modes and effects analyses.
- Define potentially effective tasks.
- Determine task intervals.
- Compare new and old requirements.

Their findings for the above three items of equipment—summarized in Figure 3—were as follows.

Implementing the RCM program for the solid-state instrument landing system made it possible to eliminate 14 of the present 27 maintenance tasks, a reduction of approximately 52 percent. In addition, extending many of the short-term inspection requirements to longer intervals made possible a change in the basic inspection cycle from 7 to 28 days. Figure 3 shows the combined effect of reducing the number of tasks while at the same time extending inspection intervals. The total number of tasks necessary annually is now 118, 84 percent

Figure 3. Results of a trial application of reliability-centered maintenance to ground communications-electronics equipment

The preliminary RCM methodology was applied to a solid-state instrument landing system, a meteorological radar, and a gas turbine generator. In each instance, the number of scheduled maintenance tasks was significantly reduced and many of the stipulated time intervals for performing maintenance were extended.



	Tasks		Tasks per year	
	Now	RCM	Now	RCM
Landing system				
7 days	12	0	624	0
28 days	6	8	65	104
56 days	4	0	24	0
84 days	2	2	8	8
168 days	4	3	8	6
Radar				
Daily	5	1	1826	365
7 days	7	0	364	0
28 days	8	1	104	12
56 days	4	3	28	21
168 days	2	1	4	2
Generator				
Daily	8	5	2920	1825
60 days	1	5	6	30
180 days	55	7	110	14
Annual	0	24	0	24
Biannual	6	6	–	–

ological radar set were likewise impressive—a requirement for 6 RCM-defined routines versus 26 under previous workcard procedures, a reduction of approximately 77 percent. Of the six RCM-defined routines required, five retain the present interval and one has an extended interval. Again, Figure 3 shows the combined effects of reducing the number of routines and extending an interval. The number of routines required per radar set per year dropped from 2,325 to 400, a decrease of approximately 83 percent. Analysis of overall performance times for maintenance routines also revealed an 83 percent reduction under RCM-generated tasks.

The objectives of an efficient maintenance program are to prevent a system's inherent reliability and safety from deteriorating and to do so at minimum practical cost.

For the gas turbine generator, trial application of RCM indicated a need for 46 maintenance tasks instead of the 70 presently performed. RCM also makes it possible to extend time intervals for 24 tasks, while reducing them for only 5. The study recommended retaining 15 tasks in their present form. Moreover, previous maintenance procedures called for 3,036 scheduled maintenance tasks per year, as opposed to 1,893 RCM-recommended tasks, a reduction of approximately 38 percent annually.

Implementation of RCM methodology

To select candidate ground communications-electronics equipments for application of the RCM methodology, ARINC Research Corporation followed the procedure outlined in Figure 2. The primary criterion for selection was potential avoidance of a significant number of maintenance man-hours. The Air Force Communications Command is considering application of the recommended RCM methodology, with the exception of failure modes and effects analyses, to these candidates. To help contractors apply the methodology to new ground communications-electronics equipment, ARINC Research also prepared a sample

The major conclusion of this study was that RCM methodology offers a workable, low-risk technique for improving the effectiveness of preventive maintenance programs for selected ground communications-electronics equipment. It standardizes procedures and documentation for generating preventive maintenance tasks; establishes historical files that document why, how, and when preventive maintenance inspections should be completed; establishes baselines for tracking and updating preventive maintenance tasks; and simplifies implementation of reliability-centered maintenance by using structures of already existing preventive maintenance programs.

Applying RCM principles to selected ground communications-electronics equipment is likely to result in a more economical scheduled-maintenance program because RCM both reduces the number of scheduled routine tasks and extends the intervals between tasks scheduled. The former increases system availability, reduces maintenance-caused failures, eliminates unnecessary routines, and avoids expenditure of maintenance man-hours. The latter increases system availability, extends component replacement intervals, increases savings by reducing spares inventory, avoids expenditure of maintenance man-hours, and extends component life. RCM methodology may hold great potential for other kinds of equipment and vehicles as well. DMJ

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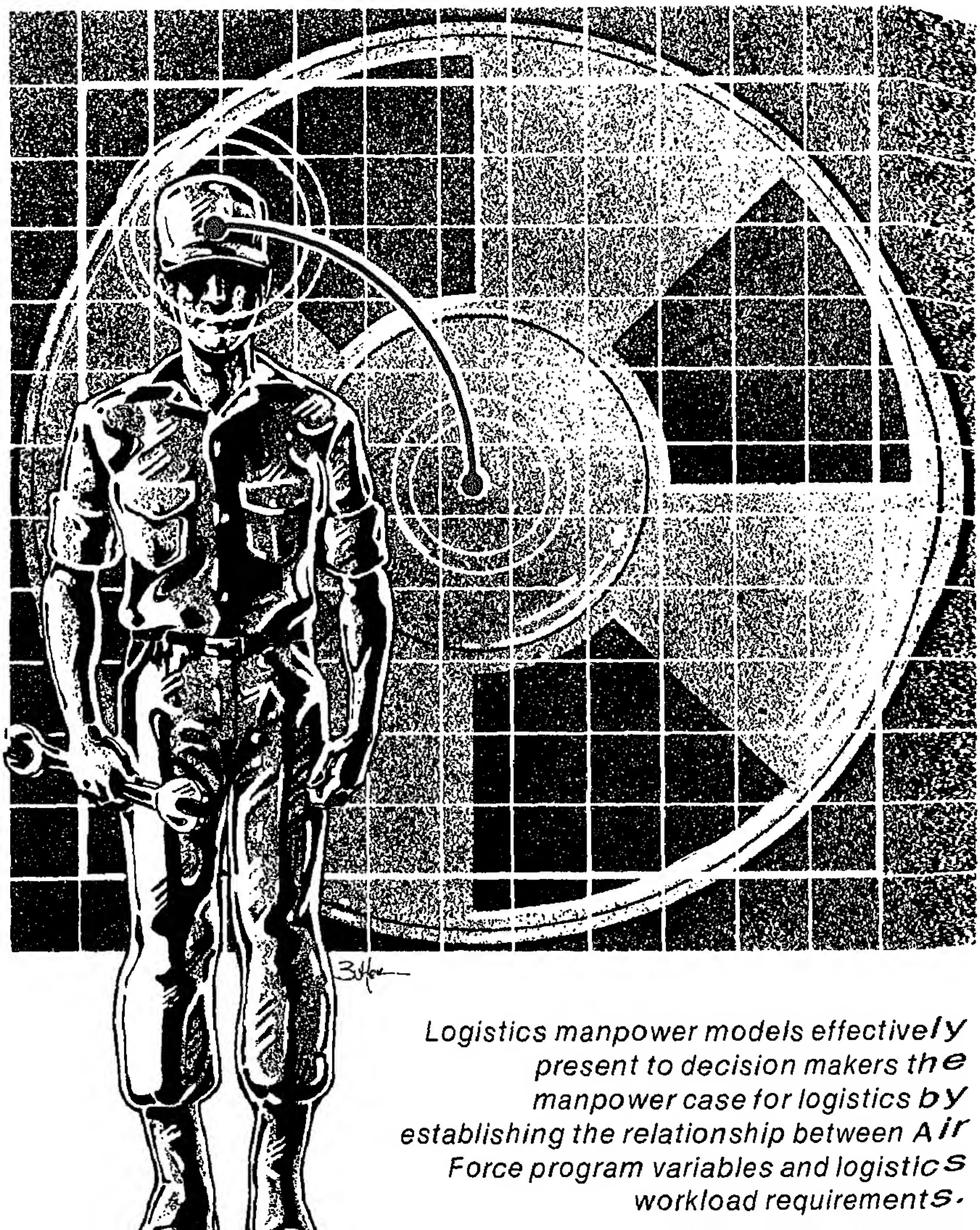

Logistics manpower models effectively present to decision makers the manpower case for logistics by establishing the relationship between Air Force program variables and logistics workload requirements.

Forecasting Air Force logistics manpower requirements

By MAJOR RAYMOND A. BLOM, USAF
and
CAPTAIN JOHN H. EVANS III, USAFR

In the early 1970s, the Air Force Logistics Command realized it was hampered in its ability to justify Air Force logistics manpower needs at Air Force and higher levels. To remedy this deficiency, management developed logistics manpower models which provide a credible basis for forecasting logistics manpower requirements.

The models are tools that can be used to project future manpower requirements by applying ratios of requirements to U.S. Air Force program variable levels. The term "program" refers to programming as used in the Planning, Programming and Budgeting System (PPBS). "Program variables" are key decision elements such as personnel levels, inventory levels of weapon systems, and numbers of flying hours programmed for each weapon system.

During periods of force reduction or build-up, these manpower models are particularly important in a support area such as logistics. While an operational command's role is direct and clearly visible, support areas are at a distinct disadvantage because they contribute indirectly to the organization's mission. Since the models were first developed, their role has become increasingly prominent; they are now the focal point for determining projected manpower levels in the Air Force Logistics Command.

Air Force policy for distributing manpower reductions across the service emphasizes the need to minimize the impact of manpower reductions on direct operational capability. Policymakers "teeth-to-tail ratio," that is, manning the fighting commands or "teeth" relative to those functions comprising the support or "tail."

The purpose of logistics manpower models is to clearly and effectively present the manpower case for logistics. They do so by establishing the relationship between Air Force programs and logistics manpower needs. Few people would dispute the basic relationship, namely, that as the level of an Air Force program, in terms of the number of aircraft and missiles, total flying hours, number of Air Force personnel, and so forth, rises and falls, the logistics support required for the program should also rise and fall. However, the appropriate size to the rise and fall in logistics support is difficult to determine.

Two important characteristics of any system used to forecast and substantiate manpower requirements are accuracy and credibility. Accuracy refers to how nearly the forecast corresponds to actual requirements. Credibility refers to how convincing the product is at higher management levels. The two features are closely related—the more accurate the system, the greater its credibility.

A serious drawback to ensuring accuracy is the difficulty in authoritatively defining the scenario or parameters to be used in determining requirements. Since a "true" requirements projection does not exist, there is no objective way to evaluate the accuracy of a system that depends on such projections. Individuals can make subjective judg-

broad reasonableness tests before they place any trust in it. Managers also expect the model to reflect the reality of the system or function as they know it. The higher the model scores on such a "test," the greater its credibility.

Given these conditions, the credibility of a large-scale manpower or personnel model appears to depend largely upon its ability to reproduce familiar details of the actual system. If test cases satisfy this criterion of verisimilitude, then a decision maker tends to trust the model's aggregate result. For a manpower requirements model, an important credibility test is how well the model presents actual organizational structure, and the logistics manpower models developed by the Air Force do this very well. They contain a very detailed representation of the Air Force Logistics Command organization. By using a detailed, building block approach to projecting manpower requirements, they produce an overall projection of AFLC manpower needs based on independent, function-by-function needs at each installation. The user familiar with a given function or system is able to evaluate the model in terms of how well it projects manpower needs for that particular function or system.

How the LMMs work

Logistics manpower models mathematically compute factors or ratios which translate macrodimensions, for example, Air Force program flying hours for a weapon system, into the microdimension of manpower (one person-year of work in a particular skill) required to perform the logistics workload in AFLC. The factors are developed from several informational elements which comprise a computational baseline. Those elements include the logistics workload accounting data for the most recent fiscal year, which is available as part of several internal management systems. Generally, the data consists of workload counts—off-base issues or procurement requests, for example—or manhours expended on managing a line item.

Another informational element is manpower requirements, which the Air Force documents in power required to accomplish varying levels of workload, they differ in the techniques and procedures used to derive those requirements. Air Force Regulation 25-5 explains the standards development process. The final elements which figure in establishing factors are the Air Force's weapon system inventory and activity and personnel levels. The model uses all these factors to project requirements based on changes in the service's programmed force activity.

A successful manpower forecasting model must answer one question—how do manpower requirements change when the organization's programs change? If, for example, an FY 1983–87 Air Force program included 16 additional aircraft with 4,800 total flying hours each year, what effect would that addition have on distribution, supply, procurement, and depot maintenance manpower requirements? For models such as the LMM, which use the building block approach, the quality of the answer to such a question depends on how two critical modeling issues are handled.

The first issue is a matter of identifying and segregating fixed and variable requirements—that is, separating those requirements which do not depend on program variables (fixed requirements) from those that do (variable requirements). Air Force programming includes many decision variables, but logistics manpower models focus only on flying hours, weapon system inventory, and base population levels. A primary example of fixed manpower requirements is management; a nucleus of management personnel is needed to cover a wide range of situations. If a weapon system's flying hours rise by 10 percent, the total maintenance manpower requirement is also likely to rise, but the increase will be in line personnel, such as mechanics, as opposed to management personnel. Ultimately, all such distinctions require judgments. If a program changes significantly, it is likely that all requirements, including management, will change to some degree. Calling a function such as management "fixed" amounts to saying it changes only when a program changes dramatically. Therefore, for most planning situations, it can be considered constant.

Of the Air Force's total logistics manpower

acquisition, foreign military sales, space systems support, communications electronics support, and headquarters staff. Other activities such as the Aerospace Guidance and Metrology Center, Air Force Museum, and the Military Aircraft Storage and Disposal Center also come under the special activities category. Each of these activities is part of the Air Force program but cannot be clearly related to program variables such as flying hours and inventory.

The second modeling issue—translating data from a local workload accounting dimension to a broader weapon system programming dimension—is critical to determining the relationship of variable requirements to the Air Force program. It involves defining and stating a mathematical relationship between local workload dimensions and the broader programming dimensions. The manpower requirement generated by applying standards to variable logistic workloads must be expressed mathematically as a requirement that can be related to program variables. In the distribution, procurement, material management, and depot maintenance logistic functions, manpower requirements are generated by merging validated internal management system logistic workload (manhour) data with approved management engineering program manpower standards.

Although system inventories, flying hours, and base populations are appropriate dimensions for the overall Air Force programming process, they are actually aggregate figures inappropriate for use by middle-level logistics managers. For the middle manager, personnel requirements can be more meaningful if related to such variables as line items managed and total issues and receipts. These variables provide detailed workload data which can be measured against standards to compute a work center's manpower requirement. The resulting requirement encompasses logistical support for all systems; however, the detailed workload data applied to individual standards also provides a key to how much of the requirement supports any specific system.

The C-130 Hercules series aircraft can be used to illustrate use of detailed logistics workload data

can also assign a prorata share of common item workloads such as tires or electronic components to the C-130. Work on the airframe, engines, or common items may take place in procurement, distribution, material management, and maintenance work centers. Regardless of where the work is done, dividing the total percentage of workload assigned to the Hercules by the computed manpower requirement for the respective work centers gives us work center manpower requirements for the C-130. Thus, based on detailed workload data, manpower requirements for the C-130 can be quantified and summed for each major logistic function at each installation.

Requirements categorized

Next, these manpower requirements are categorized as a function of inventory levels (airframe workload) or activity (engine and other workloads). At this point, we can work out relationships between these categories of requirements in each logistic function at each installation and the baseline C-130 activity. The relationship is simply a ratio of the total C-130 manpower requirements to units of active inventory or to thousands of flying hours, as appropriate. For example, each unit of inventory may generate a total logistics manpower support requirement of 1.31 persons, and each 1,000 flying hours of the C-130 may generate a manpower requirement of 5.51 persons. These relationships are the logistics manpower model factors.

The figure (p. 22) illustrates the form that such factors might take for the C-130. It shows a flying hour and inventory factor for each of four logistics functions within each of five air logistics centers in the United States. The factor values were based on FY 1978 baseline data and have since been recomputed based on FY 1979 and FY 1980 baselines.

The data indicates that logistics center E, for example, has requirements for 0.72 persons in the distribution function for each 1,000 hours that the C-130 flies. Logistics center D, however, has no requirement in the procurement function in sup-

Existing workload accounting data are collected at each Air Logistics Center. This data is used to develop within each center a flying hour factor and an inventory factor for each of four logistics functions. Using such data, it is possible to project manpower requirements to accommodate additions to the inventory or increases in flying hours.

Air Logistics Center	Factor	Manpower requirements by logistic functions: Distribution	Material Management	Procurement	Depot Maintenance	Total
A	Item of inventory	0.0	0.0	0.0	0.0	0.0
	1000 flying hours	0.2135	0.1828	0.0492	0.2037	0.6492
B	Item of inventory	0.0	0.0	0.0	0.0	0.0
	1000 flying hours	0.0530	0.0128	0.0025	0.1258	0.1941
C	Item of inventory	0.0	0.0	0.0	0.0	0.0
	1000 flying hours	0.4210	0.1779	0.0268	1.7109	2.3366
D	Item of inventory	0.0821[1]	0.0	0.0	0.0058	0.0879
	1000 flying hours	0.0588[2]	0.0	0.0	0.2662	0.3250
E	Item of inventory	0.0689	0.2582	0.0180	0.8763	1.2214
	1000 flying hours	0.7169	0.5792	0.1127	0.5953	2.0041
Total manpower per item of inventory		0.1510	0.2582	0.0180	0.8821	1.3093
Total manpower per 1000 flying hours		1.4632	0.9527	0.1912	2.9019	5.5090

[1] Indicates that for every C-130 there is a requirement for 0.0821 persons in the distribution function at logistics center D.
[2] Indicates that for every 1,000 C-130 flying hours there is a requirement for 0.0588 persons in the distribution function at logistics center D.

port of the C-130. The figures in the bottom right corner (1.3093, 5.5090) are total factors. They indicate, for example, that if 16 additional aircraft are programmed for the 1982 inventory at a total flying time of 5,000 hours, then total 1982 logistics manpower needed to support the additional aircraft will be:

Total requirements
= inventory-related requirements
  + flying hour-related requirements
= (factor × system inventory)
  + (factor × thousands of flying hours)
= $(1.3093 \times 16$ aircraft$) + (5.5090 \times 5)$
= 48.4938 persons

The translation step described earlier is essential to calculating the factors in the figure. Existing workload accounting data is collected not by weapon system but by work center. It may tell us, for instance, that logistics center E expended 20 man-years in procuring parts and subsystems used on the C-130 as well as on other weapon systems. But in order to compute a factor, we must allocate these 20 man-years across all systems on the basis of workload accounting data indicating the relative support provided to each system. Doing this involves a translation process which is conceptually simple but computationally quite complex.

Air Force programming documents include 54 categories of systems that are generally aligned with model designator groupings. Consequently, the factor development process results in 54 matrices of factors similar to those in the figure. The factors are recomputed each year based on the most recent year of historical data, our computational baseline. This snapshot in time of Air Force logistic manpower requirements and the force activity supported allows us to compute relationships. In turn, it is possible to use these relationships to project the manpower necessary to support various levels of future force activity.

mand to compute the personnel resources it needs to support various levels of Air Force program activity. The values of program variables at a given point in time—referred to as programming positions—are adjusted throughout the year as senior management implements policy decisions. Programming positions associated with key budget events such as the President's budget or the program objective memorandum are often used as a reference or base point for computing logistics manpower support.

As a tool for estimating the impact of program changes on manpower levels, logistics manpower models have other applications as well. One of these is ensitivity analyses. For example, in deciding whether to program a system's flying time at 200 hours or at 300 hours in FY 1983-84, top management needs to know the incremental impact of that decision on logistics manpower requirements. A model can provide that information and, as programmed flying hours are adjusted, can provide estimates of the impact of those adjustments on manpower levels.

Another important application of the models is allocation of manpower resources within the Air Force Logistics Command. Logistics manpower models provide the basis for projecting requirements at Air Logistics Centers, and, in turn, these projections become the basis for allocating manpower to the centers. In other words, the resources the centers can expect to receive are directly related to the activity level of the systems they support.

One example of an application in the Air Force programming environment might be a proposed C-130 fleet reduction of 8 aircraft to inactive status in FY 1983 and a corresponding reduction of 1,500 hours in flying time. Based on information input to the model, the impact on logistics manpower support would be 18.8 excess manpower slots. If the proposal were implemented, the Air Force programmed activity documents would reflect changes in force and activity levels, and allocation of manpower resources to the Air Force Logistics Command in the Five Year Defense Plan would show corresponding changes. Distribution of resources to the Air Logistic Centers is based on projected requirements, and centers would share in received because they enable the Air Force Logistics Command to directly and effectively participate in the DoD manpower programming process. The key to this success is the ability of the models to relate macro Air Force program variables to micro logistics workload requirements. They make it possible to build Air Force program activity trends into projected requirements and allocations.

In developing total requirements, the models rely on a building block approach, one that first segregates and then aggregates individual subfunctions. Factors, or ratios of current workload to current manpower levels, provide the basis for projected requirements. By applying these ratios against projected future program levels, the models can compute future manpower requirements. This approach assures management of relatively accurate projections, even given that "true" future requirements do not yet exist. The models thus represent a logical and credible system for forecasting logistics manpower requirements. DMJ

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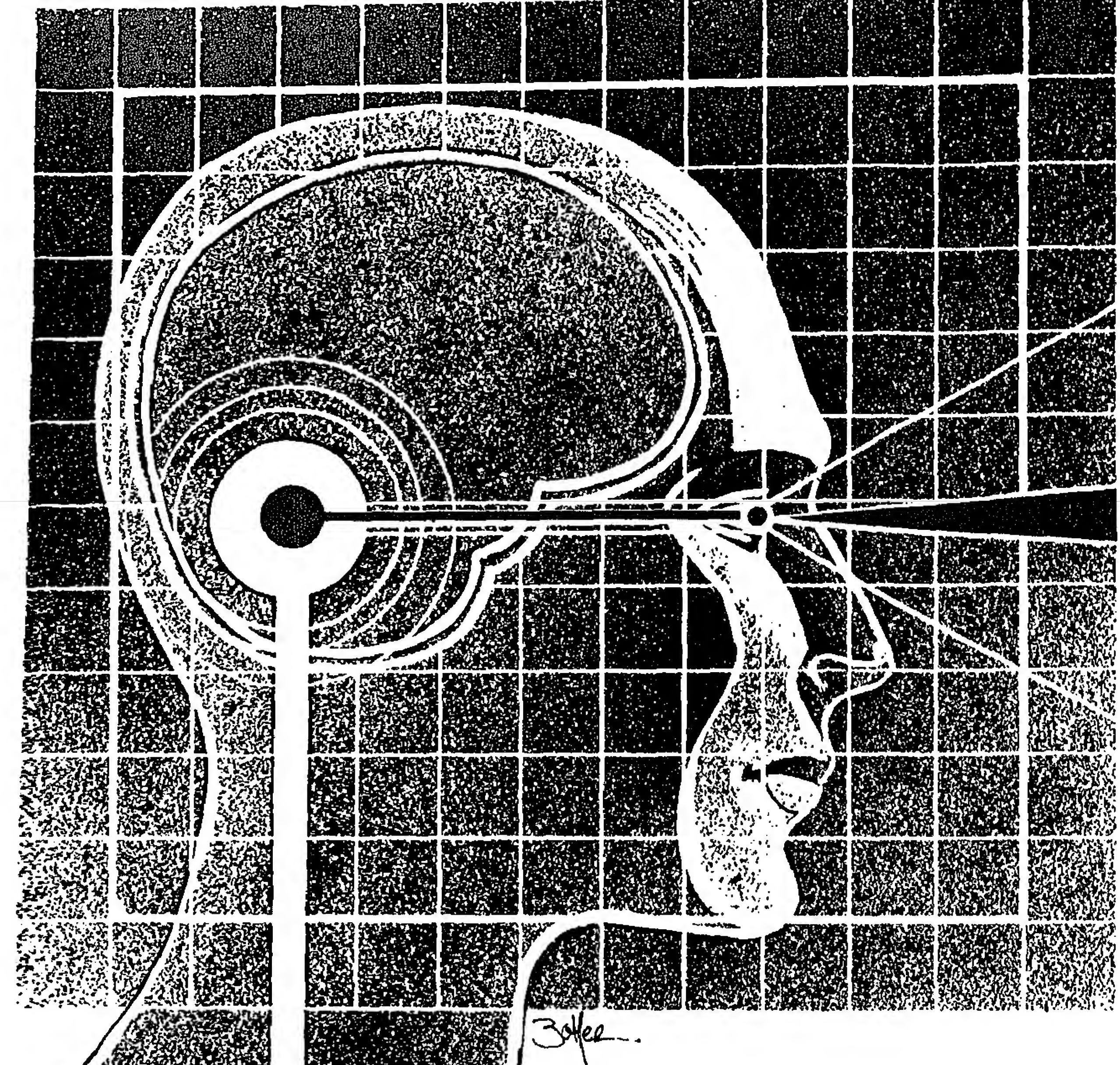

Ranking programs and projects which serve different needs and have no common standard of measurement is a difficult but necessary process. The normalized-direct method presented here allows DoD managers to simplify the task of assigning relative value

Ranking alternatives — a problem and an aid

By PETER D. IVORY

One of the toughest budgeting tasks confronting a Department of Defense manager is ranking programs and projects which serve different needs and have no common standard of measurement. Although prioritizing under such circumstances can be difficult, it is a valuable and often necessary process.

This paper offers a normalized-direct method as an intermediate step to simplify the task. The reader should be aware from the outset that ranking as a decision process is not the same as a rank order of alternatives. In most instances, a decision maker can arrive at a rank order of alternatives only after applying a variety of evaluation techniques in what is usually a long, mechanical process. By contrast, the ranking method assumes that a decision maker can accomplish the entire evaluation procedure through a process of *subjective* assessment that is much less time-consuming.

The human ability to make subjective value judgments is often accepted without question. Nevertheless, obvious limitations to this ability are explicitly recognized. A good example is the federal judiciary system—instead of one judge, the Supreme Court has nine justices; and under the court-trial system, a trial by jury insures that more than one person judges the evidence. Subjective resolution of any problem, whether it be a value judgment or mental multiplication, is subject to a basic constraint on human mental capacity. We can only process so much information.

The inherent limitation of the mind's capacity to subjectively solve problems is apparent if we view the process as a production model. In problem solving, the mind receives and processes information, assesses the relevant data, and disregards that which is irrelevant. The mind's storage and processing capacity is a fixed input; information is a variable input. For any production process, whenever one input is fixed and another continually increases, eventually the rate of output declines—the immutable law of diminishing returns applies. The amount of information needed to make a correct value decision eventually can, and often does, exceed the mind's subjective capacity.

The point of diminishing returns occurs surprisingly soon. Dr. G. A. Miller, in an article that appeared in 1956, observed that the human capacity for processing data is about 7 bits of information, plus or minus 2, where a bit of information is defined as an answer to an unequivocal question.[1] Twenty-five years later, 7 bits of information is still a rule-of-thumb used by psychologists and evaluation analysts to mark the upper limit of human capacity to process information. Many common tasks, including, for example, the task of ranking weapon systems, require value judgements based upon an information base which vastly exceeds the 7-bit standard.

The frequent assumption that more information leads to better decisions is correct, with a caveat: only if this information does not exceed the human capacity to process it. Information over and above the point of diminishing returns can actually impair the quality of decision making. As has been

* *This article was partially funded by the Foundation*

[1] *G.A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Infor-*

increase decision makers' confidence, ironically "their certainty about their own decisions became entirely out of proportion to the actual correctness of those decisions." [2]

Thus, while having more information upon which to make a judgment instills confidence, it does not necessarily improve the quality of the decision. In fact, once the information exeeds the mind's capacity to process it, the potential for errors in judgment increases.

This problem of processing and assessing information is especially acute when the parameters are value-laden and the resolution typically a subjective one. But such problems can be solved in much the same way as other complex problems where we usually do not take a subjective approach. Solutions to them usually involve a process of specifying the component parts, solving each part, and then integrating the individual solutions into a whole. We can illustrate the difficulties involved and application of the process by way of a problem defense managers face every day.

Ranking of competing alternatives for funding is one such task. Although usually considered an evaluation technique, ranking is really the outcome of a subjective value assessment process. The distinction is crucial, because ranking, *as an evaluation technique,* does not reduce the amount of information available for use in making value determinations. Furthermore, applying the techniques yields a prioritized list of alternatives, which does not provide enough information for making the best resource allocation decision.

To illustrate, take a decision maker who knows that at least one of four alternatives, ranked in order of preference, will be funded. He has ranked alternatives A, B, C, and D in descending order. Since his ranking is the outcome of an entirely subjective process, it is not possible to specify how many bits of information were processed to obtain the result. With the ranking task complete, the funding source confronts the information in Figure 1, which raises at least as many questions as it answers. Was the determination based only upon benefits? If not, how do benefits and costs enter

Project	A	B	C	D
Ranking	1	2	3	4
Cost	$40,000	$15,000	$30,000	$10,0C

into the decision? What is the relative difference value among projects? Should only project A funded? If the differences are small, shou several less expensive, lower-ranked projects funded in lieu of a higher-ranked and more expe sive project?

Not surprisingly, ranking introduces uncertain into the allocation process. It leaves unstated t criteria on which choices are based, and it does n show the relative importance of individual alte natives. In turn, the funding source, because works from a basis riddled with unknowns, h very incomplete information to guide him choosing among alternatives.

Overall, ranking requires decision makers assimilate all available information, subjective incorporate benefits and costs, and specify alte natives in order of preference. Obviously, a pro lem does not have to be very complex for rankii to be a difficult task. Unfortunately, even for very capable manager, the results can be a po representation of the effort that went into obtai ing them.

An intermediate step that can be helpful in arri ing at a final ranking is the normalized-dire method, which allows a decision maker to *quanti* a value assessment for two factors at a time. F example, he can incorporate budget and costs in a decision through the normalized—marginal ut ity-to-incremental cost—ratio rule. (This resour allocation rule is operationally equivalent to tl benefit-to-cost ratio rule.)[3] Marginal utility-t incremental cost ratios not only provide an op mum resource allocation rule, they also answer tl question: what does it take to change my decision

[2] *S. Oskamp, "Overconfidence in Case-Study Judgments,"* Journal of Consulting Psychology, 29(1965), p. 264.

Figure 2

Project	A	B	C	D
Ranking	1	2	3	4
Marginal utility	30	20	15	10
Normalized weight	0.40	0.27	0.20	0.13

Figure 3

Project	A	B	C	D
New ranking	3	1	4	2
Normalized measure	0.40	0.27	0.20	0.13
Incremental cost	\$40,000	\$15,000	\$30,000	\$10,000
Normalized cost	0.42	0.16	0.32	0.10
Marginal utility-to-incremental cost	0.95	1.69	0.63	1.30

The crux of the process lies in quantifying answers to two questions. First, how much better off will the organization be? Second, what additional costs will be incurred if the proposed alternative is accepted? The answer to the first question will be in terms of an increase in value; it is the marginal utility of an alternative. The answer to the second is simply a matter of the additional costs that result from implementing an alternative. What they seek to quantify for the purpose of comparing across alternatives is the trade-off between additional value and additional cost.

The first step in quantifying marginal utility is to rank the alternatives in order of perceived value. Assuming that the lowest ranked alternative has some positive marginal utility, its assigned value is 10. Thus for the alternatives in Figure 1, the marginal utility of project D carries a value of 10. If 15 is the value assigned to project C in Figure 1, then C is 1.5 times more important than project D. In similar fashion, all higher ranked alternatives should be given appropriate numerical measures of value.

If there are seven or more projects, a useful validity check is to drop one alternative and remeasure; the ration of values should be approximately constant. For instance, if project D is dropped, the marginal utility for project C becomes 10. Projects A and B should also get new measures of value, and then one can compare the ratios of measures before and after dropping project D. Since the ratio of values between projects B and C was 1.33, the new value assigned to B should be 13 or 14 to maintain that ratio. The last step, normalizing the final values, is a matter of dividing each measure of value by the sum of all measures across all alternatives. Except for the validity check, Figure 2 illustrates the entire process.

These relative marginal utility measures are an initial approximation and, though rough, may be sufficient. The importance of quantifying values can now be demonstrated in Figure 3.

Applying the marginal utility-to-incremental cost rule results in ranking the alternative with the highest ratio first, the alternative with the next highest ratio second, and so forth. Following this principle, the new ranking in Figure 3 would be projects B, D, A, and C. To retain the original

[3] *A normalized (marginal utility-to-incremental cost) ratio rule is more general than benefit-to-cost ratio, since benefits*

Figure 4

Project	A	B	C	D
Measure	45	20	15	10
Normalized measure	0.50	0.22	0.17	0.11
Normalized incremental cost	0.42	0.16	0.32	0.10
Marginal utility-to-incremental cost	1.19	1.37	0.53	1.10

how much? Subjectively, this question is very difficult to resolve. For example, constructing the marginal utility-to-incremental cost ratios in Figure 3 alone takes 23 bits of information.

However, by using the marginal utility-to-incremental cost ratios in conjunction with a sensitivity test, a decision maker can easily determine how much additional value must be assigned to an alternative in order to change the ranking. Under the assumption that costs are relatively firm, a sensitivity test focuses on changes in utility measurements which will change the ranking. It answers questions such as how much would project A's marginal utility measure have to increase to rank higher than project D's?

The answer is a matter of solving for MU_A in $(MU_A/IC_A > MU_D/IC_D) = (MU_A/.42 > .13/.10)$, where MU_A and MU_D are the normalized marginal utilities of A and D, respectively, and IC_A and IC_D are the normalized incremental costs of A and D, respectively. By comparing 0.55, the value of MU_A, with 0.13, the normalized marginal utility of D, one can see that the value for A must be higher than D. The relative difference between the values of A and D, not the actual value found for MU_A, is important. If the decision maker does not believe that the marginal utility for A is worth more than 4 times as much as that of D, and if these are the only values which trouble him, then rough measures are good enough.

If, on the other hand, the decision maker determines that his initial value for A should be increased to 4.5 times that of D, he is free to revise the measure. A revised MU measure of 45 for project A indicates that A is 4.5 times more important than D, the value of which was set at 10. If the measures for projects B and C remain unchanged, the new measure for A means that the value of A is now 2.5 times that of B and 3 times that of C. Obviously, if any of the differences do not correspond to a decision maker's values, then he should make the appropriate changes. Given that this change in the marginal utility for A is the only adjustment needed, the normalized weights need to be recalculated, as do the normalized (marginal utility-to-incremental cost) ratios (see Figure 4). Even with a 50 percent increase in the value of project A, the new ordering of funding is still B, followed by A, D, and C.

The normalized-direct method is thus a *process* for solving problems of choice; it involves identifying parts, quantifying values, allocating resources by applying a utility-to-cost ratio rule, and using a sensitivity test to validate results. The entire procedure takes only a few minutes and a hand calculator. In addition to providing a better thought-out ranking of alternatives, this method allows a DoD manager to express the relative value of those alternatives. While this technique allows more information to be consistently evaluated, evaluation of multidimensional choices will eventually require even more sophisticated techniques.[4] DMJ

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[4] *The next level in sophistication is probably the Simple MultiAttribute Rating Technique (SMART); a good discussion of this technique can be found in: W. Edwards, "How to Use Multiattribute Utility Measurement for Social Decisions*

support systems

By JOHN W. WOOD, JR.

The General Simulation System, which offers a simple, inexpensive, high-level simulation language, enables the logistics manager to construct a realistic logistics flow model with queuing statistics and probability distribution automatically calculated.

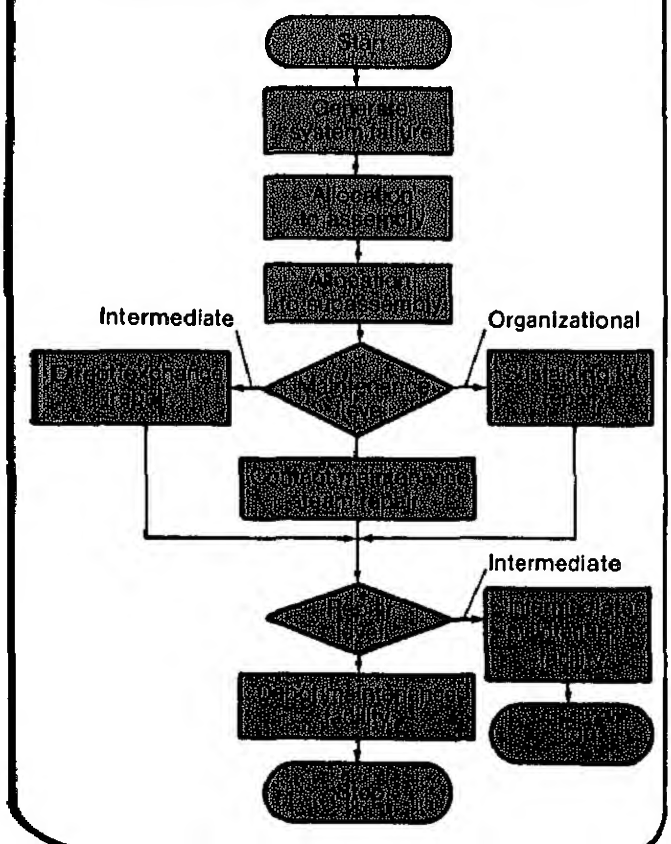
Approximately 50 percent of the DoD budget is allocated to operations and support costs. The magnitude of these expenditures makes it imperative that we thoroughly analyze the effectiveness of logistics support systems, which account for as much as 60 percent of the cost of many hardware programs. At a time when current defense contracting practices have introduced incentives to lower life cycle costs, the logistics manager also faces the challenge of designing supportability into new products to similarly reduce life cycle costs. His analytical tools used to achieve these objectives include numerous complex models for logistic support analysis, level of repair analysis, and life cycle costing, each of which exists in various forms and has varying degrees of credibility, depending upon the service or the specific contracting command.

What the logistics manager needs is a simple, low-cost methodology for determining the impact of the mean-time-between-failure and mean-time-to-repair design factors on logistics support systems; such a methodology should be adaptable to the specific logistics support system under design. General Purpose Simulation System V

years ago, the system is now used by a number of major contractors, several large corporations, and the federal government. GPSS enables the logistics manager to construct a realistic logistics flow model with queuing statistics and probability distributions automatically calculated.

The GPSS V language allows a logistics manager to simulate the logistics system for a given product. By varying predicted mean-time-between-failure and mean-time-to-repair factors, he can arrive at a rationale for specific mean-time-between-failure and mean-time-to-repair design goals. Having formulated design goals, the logistics manager can then use the model to evaluate alternative maintenance concepts. Each evaluation will generate the expected resource utilization and probabilities associated with repair, supply, and transportation distributions. After

Figure 1. A typical simplified logistics support flow diagram



mine support equipment requirements, customer manpower recommendations, equipment availability predictions, life cycle cost estimates and drivers, and provisioning recommendations. As test and operational data become available, he can also do logistic impact studies, which will provide the Integrated Logistics Support program manager with quantitative assessments of how the system is performing and tell him where management can improve operational availability.

The unique capability of the GPSS V language to sample probability distributions and to automatically queue system failures at critical points within the system significantly reduces the complexity of the model. Each maintenance element in the logistics flow model gathers queue statistics such as average number of failures in queue, maximum contents of queue, and average time spent in the queue. Personnel resources can be assigned in sufficient numbers to provide the service needed or, if constrained, to work on a first-come, first-serve or priority basis.

The most significant contribution of the GPSS V simulation methodology is the detailed and quantitive understanding the logistics manager derives from studying the relationships between elements of a total logistics support system. The simulation model provides a reference against which the Integrated Logistics Support manager can measure the performance of supply, transportation, and maintenance activities. The model can also readily accommodate evaluations of competitive logistics situations using two or more products.

Formulating the simulation model

The objective of the simulation model is to provide a realistic representation of the logistics support scenario. Estimating mean-time-between-failure and mean-time-to-repair on the basis of empirical data from similar equipment provides the logistics engineer with enough information to gain insight into the potential structuring and operation of a logistics support system.

Following a programmed failure through a typical simplified logistics support scenario (see Figure

determines the assembly, by assigning another random number, a second probability distribution

The most significant contribution of the GPSS V simulation methodology is the detailed and quantitative understanding the logistics manager derives from studying the relationships between elements of a total logistics support system.

selects a specific subassembly from the assembly complement. Associated with the specific subassembly is a code which indicates the first stop in the repair scenario, such as direct support, and the final repair level such as depot.

The simulation clock is advanced according to calculated times for maintenance, transportation, and module repair. In this particular simulation, the failed subassembly incurs a delay for transportation before arriving at a depot queue for repair and incurs another transportation delay when returned to the supply system. Eventually, the system is repaired and the downtime calculated.

The above simulation involved a single piece of equipment. But we can also run the model for the total operational hours for a given year with a specific number of equipments. The model stops after the specified amount of time, and the logistics engineer then gathers the statistics which indicate the stress on the logistic support system. This simulation gives the logistics manager enough information to scope a given system. Among important items of information he receives are:

- Organizational kit utilization by subassembly.
- Support exchange utilization by subassembly.
- Contract maintenance team utilization.
- Intermediate and depot workloads by subassembly.
- System availability.
- Percent resources in transit.

and customer can readily understand the methodology. By placing names of variables within the main logic flow, while placing definitions of variables and functions in front of the program, the simulation methodology facilitates changes, sensitivity runs, and trade-off studies. With a minimum preparation of 10 to 15 hours, the logistics engineer can program his first simulation and scope the impact of the design values of mean-time-between-failure and mean-time-to-repair.

Approximately 50 lines, each composed of a logical word followed by a limited number of operational fields, would be sufficient to code the logistics support scenario shown in Figure 1. Documenting each line further clarifies terms. If the first segment creates a failure, subsequent coded statements attach the majority of the specified parameter values from the input probability distributions. The failure moves through the system when the GPSS discrete timeclock determines that the failure has completed each element of the scenario.

Figure 2. Intermediate maintenance requirements for spares by shop-replaceable assembly

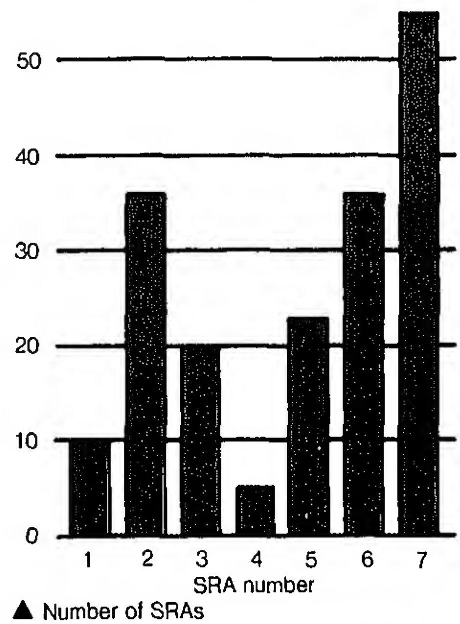


Figure 3. Intermediate maintenance activity workload statistics by shop-replaceable assembly

SRA No.	Maximum contents queue	Average contents queue	Total failures queue	Average time spent queue
1	10	.010	110	120.5
2	36	.166	40	360.4
3	20	.811	910	239.1
4	5	.243	120	80.6
5	23	.611	611	300.5
6	35	.321	96	74.3
7	55	.432	13	534.1

Movement proceeds according to directions and times stored in parameters associated with each failure. The assigned maintenance action level and subassembly repair level direct the failure to the appropriate module. The transfer code states that for some variable percent of the time a contact maintenance team will have to repair the equipment. In the remaining programmed time, the failure will flow to an organization, intermediate direct exchange, or intermediate contact maintenance team, as specified by a parameter. The model has timers which calculate downtime, queues which formulate system quantities and subassembly quantities, and tables which sum-

Figure 4. A typical user-formulated matrix for gathering related system times

SRA No.	Total system failures	Repair time	Transportation time	Total time	Average turnaround time
1	864	25920	129600	156520	185
2	1103	44120	220600	264720	240
3	602	24080	120400	144480	240
4	352	10560	52800	63360	180
5	101	3030	15150	18180	180

deviations.

The GPSS also provides complete labeled graphs, matrix outputs, cumulative probability distributions, queue statistics, and even text output. Figures 2 through 6 provide samples of typical outputs.

Figure 2 (p. 31) graphically represents inventory at the point of intermediate direct exchange. If the logistics manager does not limit the amount of inventory stored, then the estimated number of assemblies and subassemblies exchanged in a given resupply time would be the basis for a "never-out" provisioning recommendation. However, the inventory storage component of the model can also accommodate nonavailability of supplies or receipt of supplies. The inventory storage displayed in tabular form in Figure 3 shows maximum contents, average contents, total parts processed, and average time processed. Figure 4 is a typical user-formulated matrix for gathering related system times. Once past the "advance" block, each time the clock moves, the time is recorded and can be added to transportation and repair time, as appropriate. Summing the transportation and repair times provides the total logistics support time. By dividing total time by the number of failures, the logistics manager can determine average turnaround time. A simple calculation will also yield operational availability data.

Cumulative probability distributions of some typical system times are shown in Figures 5 and 6. The significance of presenting data as a probability distribution is that the decision maker can quantify risk. For example, Figure 5 allows him to quote a 70 percent probability that the system will be down less than 180 hours. Figure 6 makes it possible to state that intermediate repairs are completed in less than 300 hours, 60 percent of the time.

Methodology evaluation

GPSS V simulation methodology is not a new technique for scoping design and logistics support requirements, but it is an effective one because of its simplicity in terms of comprehension and coding. Like any com-

Figure 5. Total system downtime probability distribution

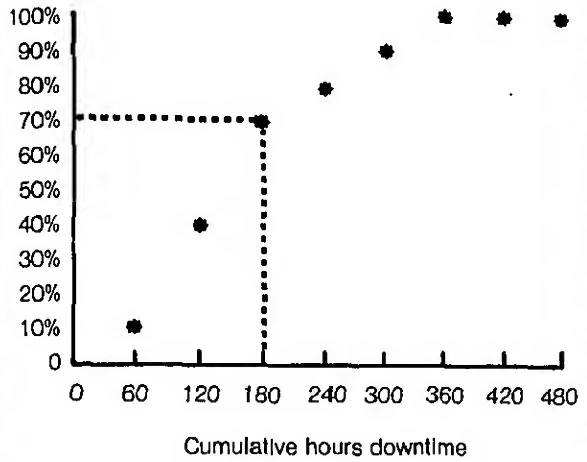
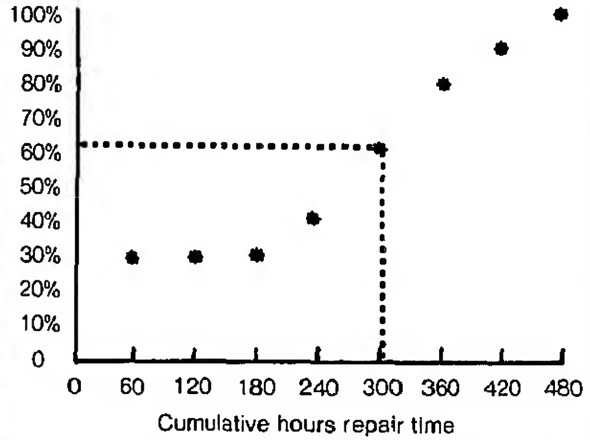


Figure 6. General-support module repair time probability distribution



ing response to this concern, is to construct a model operational system which provides sufficient reliability, maintainability, and availability data. Valid selection of input parameters can easily simulate the last quarter's reported logistics support stress and estimate the current quarter's stress prior to publication. The author has performed such a validation with less than 1 percent error in accuracy.

A simple, low-cost, high-level simulation language such a GPSS V is an effective management tool. It enables the logistics engineering manager to evaluate design parameters which impact a logistic support system. Using GPSS V, he can, for example:

- Quantify and validate spare lists.
- Support equipment requirements.
- Estimate pipeline resources and repair facility manpower requirements.
- Project the impact of product improvement.
- Validate life cycle costs.
- Estimate operational availability.
- Evaluate alternative maintenance concepts.
- Quantify sensitivity of mean-time-between-failure and mean-time-to-repair.

The GPSS methodology is a tool he can use in designing and planning logistics support for new products. It can also help him justify funding requirements for additional spares and other system improvements. The concensus of those using GPSS is that the language is exceptional. With GPSS, for example, it is possible to produce a graph in four lines, a task that might take several pages with another language such as Fortran. Most importantly, the methodology gives the logistics manager a vehicle for fast trade-off analysis and impact studies from the conceptual phase through the operational phase. DMJ

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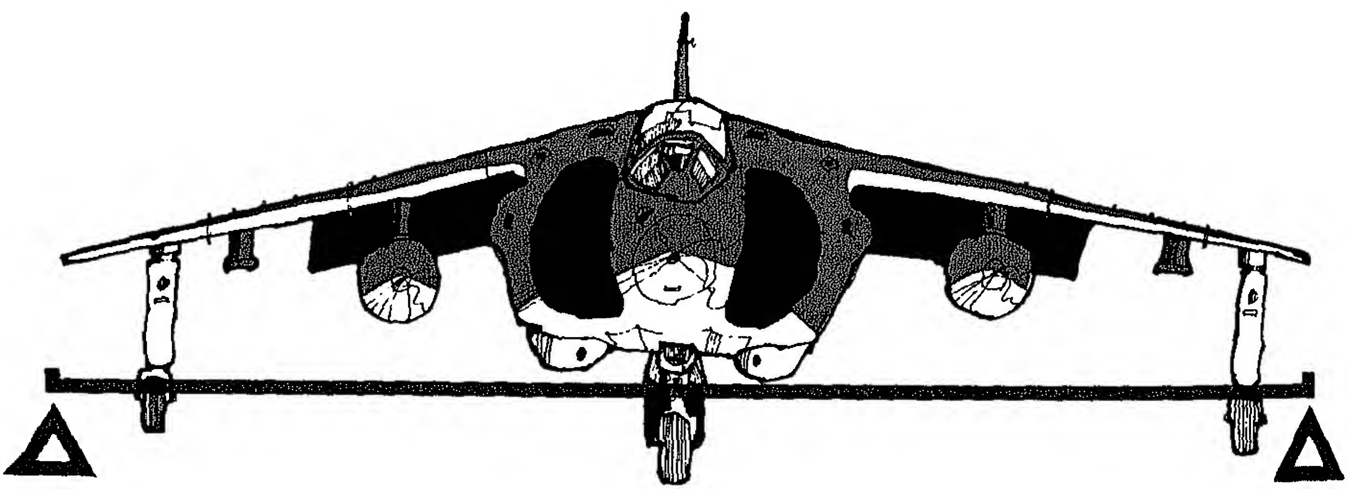
Ensuring optimal system acquisition through life cycle costing

By PAUL J. McILVAINE

By using a single life cycle cost structure and common costing factors in its Tactical Combat Operations system acquisition program, the Marine Corps is striving to ensure that the optimum system is selected.



Despite the many quantitative techniques and computerized aids that have been developed, life cycle cost management remains an inexact science but one we cannot do without. Although many problems hamper the life cycle costing process, a major one takes the form of a paradox: information on the life cycle cost of a system is most valuable at milestones I and II of the Systems Acquisition Review Council process; however, reliable cost information is also most difficult to obtain at these decision points because the system usually does not exist yet. Conversely, more reliable cost information is usually available at the milestone III and post-milestone III decision points, when it is of least value because the system has been effectively "locked in" by then.

One consequence of this paradox is that program managers usually make a major, unwritten management decision (sometimes by default) either to give life cycle costing the serious attention it deserves or merely to pay it "lip service." This need not be the case, as the Marine Corps' experience with the Tactical Combat Operations system demonstrates. The Tactical Combat Operations system is one of a number of systems being developed by the Marine Corps to provide Fleet Marine Forces with modern command and control capability so that they can better cope with the increased tempo and complexity of post-1980 battlefields.

Marine Corps system acquisition policy for the Tactical Combat Operations system, as for other Marine Corps systems, is unique within the Department of Defense because of the relatively small size and nature of the Corps. Instead of program managers within Headquarters, Marine Corps, a committee called the Acquisition Coordinating Group, which functions without a chairman, normally provides program management. The group usually assigns many responsibilities, including life cycle cost management, either collectively or to individual members.

Within the Corps, a board of general officers, known as the Marine Corps Systems Acquisition Review Council, reviews critically important programs and the Commandant exercises final approval authority. MSARC reviews normally coincide with milestones I, II, and III and deal with critical issues of performance objectives, life cycle cost, supportability, cost effectiveness trade-offs, organizational and doctrinal implications, test results, and the like.

Normal Marine Corps procedures during the early phases of a system's development involve conducting both life cycle cost analyses and cost effectiveness analyses. The results of these efforts are then presented to the council at the major milestone reviews.

A need for improved cost information

A gradual awakening to the need for better management of life cycle costing on new programs ments of the causes for cost overruns on previous programs did not reveal whether the problems were due to inaccurate or incomplete estimations. Life cycle cost analyses performed on individual programs used different structures and assumptions and hence gave rise to questions concerning the completeness and accuracy of the analyses. To further complicate matters, program managers had not always explicitly stated their assumptions relating to what was and, equally important, what was not included in life cycle cost formulations. This lack of information seriously impeded independent assessments and audits of these formulations. Comparisons between projects or between different analyses of the same project, if made at all, were both difficult and expensive to accomplish.

Since comprehensive documentation on each source of cost information existed for few projects, tracing the sources of individual cost elements was virtually impossible. Exacerbating this problem was the rapid turnover—every 3-to-4 years—in project personnel, which resulted in a loss of corporate knowledge. This rapid turnover largely precluded any effort to efficiently and progressively refine and update life cycle cost estimates on any large-scale program.

In addition, manual methods of computing life cycle costs and evaluating the implications for system and design alternatives were proving too tedious and time-consuming to be effective. This problem was especially acute for a complex command and control system such as the Tactical Combat Operations system which consists of multiple numbers of individual electronic units or black boxes.

The net effect of these problems was to severely limit the usefulness of life cycle cost estimates as a management tool. They rarely exerted any significant influence on Marine Corps programs such as the Tactical Combat Operations system. In 1979, the TCO system was only two years away from a milestone II decision point, yet life cycle cost management of the program had received little emphasis. Unfortunately, several problems had surfaced:

- *Life cycle costing was being confused with*

program budget, which did not include personnel, replenishment spares, and some other key operation and maintenance figures, as the program's life cycle cost.

• The specific sources, dates, and definitions of many individual cost estimates had not been documented and therefore could be neither substantiated nor challenged.

• Finally, program managers had used different life cycle cost structures, methodologies, and assumptions in estimates completed prior to 1979.

Overall, these problems would prevent life cycle cost estimates from influencing the Tactical Combat Operations program during the full-scale development state.

Problems such as these prompted the convening of a Marine Tactical Command and Control System life cycle cost conference in 1978. As a result, a Marine Corps life cycle cost model project and a steering committee were established. This effort led to the development and adoption of a standard Marine Corps cost structure for portraying the life cycle cost of electronic systems. A standard Marine Corps life cycle cost model was also developed that would utilize the cost structure to facilitate the development and progressive refinement of life cycle cost estimates for electronic systems. Finally, it was decided that documentation would be published that would thoroughly describe the model, provide clear and concise operating instructions, and facilitate the recording of specific sources and methodologies used in arriving at individual cost estimates.

The project was begun with an examination of government and commercial life cycle cost models to determine if an existing model could be adopted to meet Marine Corps needs. Because of its applicability to electronic systems, good (non-proprietary) documentation capability, projected lower development costs, and shorter modification schedule, the Army's TRI-TAC life cycle cost model, developed by the Joint Tactical Communications Office at Fort Monmouth, was chosen. Initial modifications were made to allow:

• Operation in an interactive mode.

• Storage and retrieval of multiple numbers of data bases.

• An option to print out the entire data base.

• Additional ...

Significant changes were later made to the so[ft]ware program that permitted two levels of equ[ip]ment definition, conversational English langua[ge] prompting, inflation and discounting, and the [use] of Marine Corps military occupational speciali[ties]. The two-level approach accommodated both [the] system and its multiple black box components.

Documentation maintained pace with the so[ft]ware modifications. A complete set of operat[ing] instructions and a data collection workbook, [in]cluding a complete description of the model a[nd] convenient source documentation media, w[ere] available concurrently with the new program.

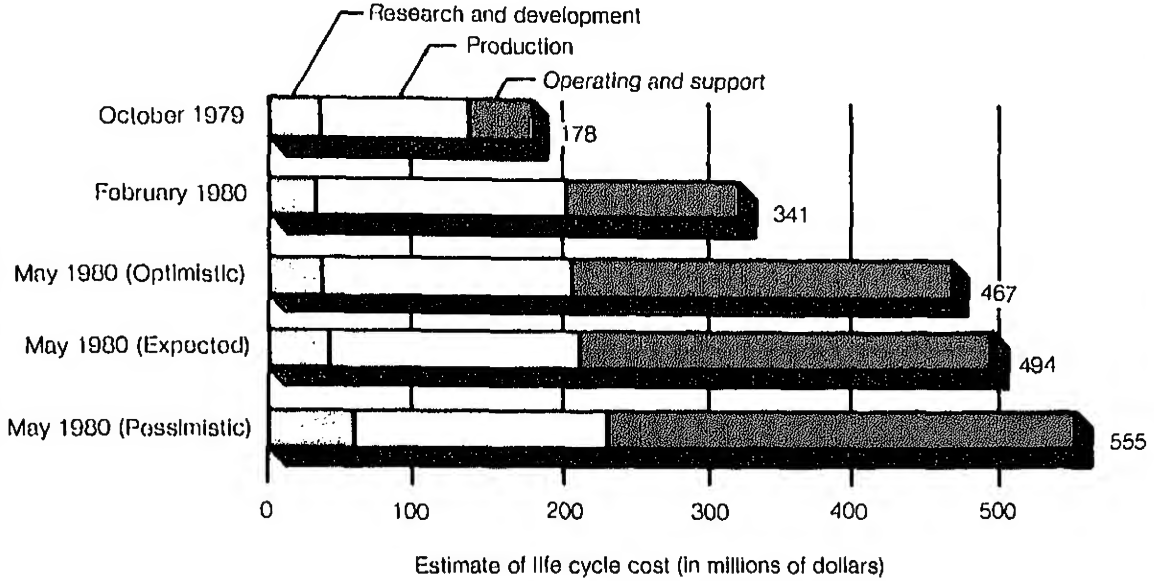
The Marine Corps life cycle cost model was [set] up on a commercial computer time-sharing n[et]work and made available to acquisition progr[am] managers. The establishment of this syst[em] enhanced the Marine Corps' capability to deve[lop] its own life cycle cost estimates as well as to e[ffi]ciently track other cost estimates.

Application to tactical operations

The complexity of the Tactical Combat Ope[ra]tions system and the need to establish and moni[tor] its life cycle cost spurred the Corps into introd[uc]ing the cost model into the acquisition progra[m]. Since the model provided only a costing fra[me]work, an initial data search and consolidat[ion] was undertaken to include the specifics of the T[ac]tical Combat Operations system into the co[m]puter. Analysts began the arduous task of c[on]structing a complete, initial life cycle cost d[ata] base. Sources were gleaned from earlier stud[ies], similar systems, experts in the field, and elsewhe[re]. Parametric estimates, analogies, engineering e[sti]mates, and expert opinions were all used to so[me] degree as basic sources of initial data. To arriv[e at] the cost estimate, analysts were guided by the pr[in]ciple of clearly documenting each element of c[ost] in the data base as to source, date, and the me[th]odology employed.

This effort resulted in the February 1980 pu[bli]cation of a fully documented, life cycle cost e[sti]mate for the Tactical Combat Operations syst[em]. This publication established a common basis [for] definitional factors such as total years of o[p]...

Between October 1979 and May 1980, the Marine Corps offered more program participants an opportunity to become involved in analyzing the original life cycle cost estimates of its Tactical Combat Operations system. As the analyses were increasingly refined, it became obvious that the original projection of cost was both inaccurate and incomplete.



factors that could be expected to change, such as maintenance time, field reliability, and cost of support equipment. This cost estimate report was circulated to all major program participants.

In turn, a number of individual cost elements were challenged by program participants who provided a different estimate. These differing estimates were accomodated by the creation of three data bases—an expected, an optimistic, and a pessimistic assessment of the life cycle cost of the system. New numbers were entered into these categories based on the quantitative values of the estimates. Accordingly, a revised Tactical Combat Operations life cycle cost report was issued in May 1980. The report contained three estimates of the life cycle cost of the program. It is interesting to note (see the figure) that the range of the three estimates was significantly outside the original life cycle cost estimate of October 1979.

The next step was to make the life cycle cost model and its data base available to major program participants for use in the conduct of further studies and analyses. The theory was that if every- a single cost structure, it would enhance effective communication among program participants.

Initially, there was some concern that any participant could change the basic cost or computational structure of the model, thereby destroying the effectiveness of the common frame of reference. Further concern was expressed over the likelihood of undocumented changes to individual cost element estimates and the detrimental effect such changes would have on efficient communications and the audit trail. However, these potential drawbacks were overcome through the imposition of configuration controls on the source code of the model itself and on the official data base from which proposed changes in cost estimates could be identified and assessed.

Centralized maintenance of the life cycle cost model software was adopted to avoid changes that would destroy the cost structure of the computational characteristics of the model's algorithms. Since the model was already on a commercial timesharing system, tampering with the source code was inhibited by placing only a compiled version

Insuring the integrity of the data base was more difficult. Admittedly, the desired objective was to allow all users maximum freedom in changing individual cost element estimates. At the same time, it was essential to be able to track all new changes to the baseline by comparing them with the old baseline. New baselines could then be logically and chronologically established which, in turn, would indirectly promote a further refinement of cost estimates.

By putting the baseline data in a protected (read only) file controlled by the Marine Corps Acquisition Coordinating Group, the initial organizational groundwork was laid. Other users of the life cycle cost model could establish individual data bases by reading the baseline data into their own data file and could change any or all of the cost element estimates as desired.

An audit trail supports the official data base by providing a cost element estimate that cites the originator of the estimate, as well as the value, date, and methodology utilized in arriving at the specific value. This audit trail consists of handwritten entries in the master data collection workbook, and is controlled by the coordinating group. Updates of cost element estimates are prohibited unless accompanied by corresponding audit trail information.

Documenting the sources of data which comprise the data base is the only way to insure that the integrity of the life cycle costing system remains intact when it is transferred from one project officer to the next. This will also insure future opportunities to refine the data base in a progressive, efficient, and effective manner.

There was little difficulty in convincing all program participants involved in life cycle costing to utilize the identical cost structure in formulating independent estimates of total program life cycle cost. It was obvious to all participants that an online, debugged program, with an available and secure data base backed by an audit trail, provided a more efficient approach than having to start from scratch. Moreover, it proved to be the most inexpensive method of becoming operational. The only equipment requirements were a commercial have an automated life cycle cost model.

The Marine Corps Operations Analysis Group of the Center for Naval Analyses was the first to utilize the life cycle cost model in their independent cost and operational effectiveness analyses. Since Marine Corps acquisition policy is to utilize existing or other services' systems in lieu of new development, this analysis will explore the feasibility and cost effectivity of the five identified major Tactical Combat Operations system alternatives under consideration:

- The Air Force Command Area Force Management system.
- The British WAVELL system.
- A variation to the Army Tactical Operations system.
- The Canadian Tactical Army Command and Control data system.
- A follow-on to the Marine Integrated Fire and Air Support system, using common equipment.

An identical cost structure will permit the "apples to apples" foundation so necessary for an honest comparison of alternatives within the cost and operational effectiveness analyses.

The prime contractor for the Marine Integrated Fire and Air Support system, the Norden Systems Division of United Technologies, is employing the identical life cycle cost model in an engineering study of the Tactical Combat Operations system as a follow-on to the MIFASS. This study will examine the technical feasibility of developing the Tactical Combat Operations system using common and unique software and hardware identical to that being developed under the MIFASS program. Life cycle cost estimates will be a part of

The theory was that if everyone used the same life cycle cost model containing a single cost structure, it would enhance effective communication among program participants.

a true comparison of contractor, independent analytical organization, and government life cycle cost estimates. This is a significant advancement over the previous method of employing three separate life cycle cost estimates, each with its own assumptions that would negate any influence that life cycle cost could have on the selection of the preferred system for full-scale development.

Painstaking management

Applying life cycle cost methodology to the Tactical Combat Operations program is not a one-shot deal. It is a process that must be painstakingly managed. It also requires rigid documentation and control procedures. These procedures, combined with the life cycle cost model, encourage and support efficient and progressive updates of life cycle cost estimates. In turn, outputs from each successive iteration have improved thus far.

Additionally, two previous problems in estimating life cycle cost—completeness and accuracy—have been reduced to manageable proportions. The completeness of life cycle cost estimates can be easily assessed by means of the cost structure. A quick review to insure that each category in the cost structure has been included in a total estimate will shed some light on the question of completeness.

The accuracy of life cycle cost estimates, although a more difficult problem, can be reduced in the early stages of a program by concentrating solely on the relative accuracy of estimates. This can be accomplished by directing that identical common factors, such as total years of operation, operating hours per year, government operating personnel costs, and so forth, be used where appropriate, and by establishing an initial range (optimistic, expected, and pessimistic) of life cycle cost estimates that represent the bounds of initial agreement.

A concerted effort on the part of all program participants to provide the best cost estimates available at the time will also help to further narrow the problem of accuracy. The shortcoming in this approach is not in getting subjective cost estimates, but in getting undocumented cost esti-

of life cycle cost estimates in today's volatile economy is not a valid expectation of any contemporary program.

Barring unforeseen difficulties, a successful milestone II decision point represents a tentative commitment to produce and deploy a weapon system. It also usually marks the point at which a specific major system alternative is selected to undergo full-scale development. Hence, the opportunity to exert significant influence on the system acquisition process by applying life cycle costing normally occurs at this decision point.

Each major system alternative will undoubtedly involve different life cycle cost, system effectiveness, and schedule implications. A good decision process will insure a careful consideration of, and balance among, these three factors. Moreover, in selecting a major system from a variety of alternatives, it is important that the measures of dollar resources, effectiveness, and timing have relative accuracy. This is considerably more important than the absolute accuracy of any values used.

The use of a single life cycle cost structure, common costing factors, open communication and feedback among program participants, rigid discipline of documentation, and a convenient methodology (such as a computer) for tracking costs can make significant inroads in overcoming many life cycle costing problems. In an era of increasingly high-priced weapons systems and growing program costs, the services cannot afford to throw up their hands in desperation. The approach used on the Tactical Combat Operations system acquisition program represents one way of insuring that the optimum system is selected. DMJ

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You bet your life — the Survivor Benefit Plan

By WILLIAM C. LETZKUS
and
CHARLES R. MARGENTHALER

Have you recently made any $200,000 decisions that affect the well-being of your family? All professional military members face such a decision *shortly before they retire, when they must decide* whether they wish to participate in the Survivor Benefit Plan and, if they elect to do so, to what extent. Participation in the plan may cost the military member thousands of dollars. Failure to participate may cost a member's survivors several hundred thousand dollars. About 75 percent of the officers and 40 percent of the enlisted members retiring from the armed services elect to take part in the Survivor Benefit Plan.

The decision to participate is solely the responsibility of the military member and his spouse. This study seeks to contribute to a more informed decision; it does not make a recommendation for or against participation. To understand the *economic ramifications of the decision a member* needs to understand how the Survivor Benefit Plan functions, how it interfaces with the Social Security system, and how the social security offset for SBP benefits works.

To further such an understanding, the authors will briefly discuss the major features of the SBP system and the computation of its benefits, explain the computation of social security benefits based on military service, and demonstrate the SBP social security offset. Because of the many possible scenarios which can exist for SBP and social security benefits, this study addresses only the basic requirements of these systems. For the sake

and no dependent children. Further, to avoid cumbersome, duplicative references, the authors of this study assume male retirees and female spouses. *The reader may wish to reverse these* roles.

The plan itself

On October 10, 1980, President Carter signed into law Senate Act 91 which amended the law regarding the Survivor Benefit Plan. The major provisions of the new law allow the surviving spouse to receive at least 60 percent of the SBP annuity, even after the social security offset, and make the method for determining the cost to a military member the same as for a civil servant.

Under the SBP, a member's designated survivors receive a monthly annuity, which is always 55 *percent of some base amount.* The member may elect as a base amount his gross retirement pay (the maximum base), $300 (normally the minimum base), or some amount in between.

The SBP annuity costs are deducted directly from the member's monthly retirement pay. At the time of SBP election, the cost for spouse-only coverage is 2½ percent of the first $300 of the base amount, plus 10 percent of any remainder in the base amount. Thus, for example, the monthly SBP cost for a $1,000 base amount would be 2½ percent of $300 plus 10 percent of $700, or $77.50. Coverage for dependent children is available for only minimal additional cost.

cost-of-living adjustments. (Widows already receiving SBP annuity payments receive the same percentage cost-of-living adjustments.) Because future SBP annuity payments to a surviving spouse will reflect these adjustments, SBP costs to the retiree will also increase. However, Senate Act 91 changed the formula for determining additional SBP costs associated with cost-of-living adjustments. Basically, these costs now increase by the same proportion as does the member's retirement pay. A 10 percent cost-of-living increase in the $1,000 base amount discussed above, for example, would result in a base of $1,100 and would increase the corresponding monthly SBP costs by 10 percent of $77.50, pushing the monthly cost to $85.25.

Only net retirement taxable

SBP costs are excluded from gross income and thus from federal income taxes, so that only a member's net retirement pay (gross retirement pay less SBP costs) is taxable. Most states also tax only net retirement pay.

Normally, a member cannot change his participation in SBP once his application becomes effective. However, Congress did authorize a one-year open enrollment period beginning October 1, 1981. During that year, eligible retirees may enroll in the program for the first time, increase coverage, or include spouses where only children were previously covered.

Deductions from retired pay continue as long as the retiree has a beneficiary eligible for the annuity, although they will stop if his spouse dies before him or if he is divorced. Should the retiree remarry, his new spouse becomes an eligible beneficiary. The same SBP coverage that was in effect for the former spouse and a current liability for deductions from retired pay begin one year after the remarriage. Any additional costs for coverage of children end when the youngest child reaches age 18 or, if in school, age 22.

SBP annuity payments to a covered widow continue until her death, unless she remarries before age 60, in which case the annuity ends. However, if that marriage ends for any reason, her SBP annuity payments resume; if she should remarry

ject to federal income taxes.

If a widow aged 62 or older is entitled to a social security survivor benefit based on her husband's covered employment, her SBP annuity is subject to mandatory reduction. The reduction becomes effective even if she does not apply for social security survivor benefits or is entitled to a greater benefit from her own covered earnings. However, if a widow is working and, because of her income, is not eligible for social security benefits, she continues to draw her full annuity.

A widow under age 62 also receives her full SBP annuity unless she is receiving either social security survivor benefits or a mother's social security benefit because of one dependent child in her care. Her SBP annuity remains intact if she is receiving a mother's social security benefit because of two or more dependent children in her care.

Reduction of a widow's SBP annuity (hereafter called the SBP offset) is based solely on the member's social security "covered" wages (including military wage credits) earned on active military service after 1956. Any social security benefits earned in civilian employment have no impact on the social security offset. The amount of the offset is the lesser of 40 percent of the SBP annuity or that portion of social security survivor benefits attributable to military service after 1956.

Determining the SBP offset

Both the social security offset and the SBP itself are thus fairly straightforward. Computation of social security benefits based on active military service after 1956 is more complicated, however, and little understood by most military members, due to changes and complexities introduced by the 1977 amendments to the Social Security Act. But because these benefits wholly determine the amount of the SBP offset, an understanding of social security benefit computations is critical to an understanding of the SBP offset.

Relevant changes introduced by 1977 amendments include provisions for indexing wages and a new benefit formula, both of which went into effect on January 1, 1979. The provisions require that the earnings of a worker first eligible for benefits *after* 1978 be indexed to reflect changes in

Figure 1. The maximum Social Security wage base, average wages, and projected average wages for the years 1957 through 2002

Year	Maximum Social Security wage base[1]	Average wages (actual)	Year	Average wages (projected)
1957	$ 4,200	$ 3,641.72	1979	$11,400.51[2]
1958	$ 4,200	$ 3,673.80	1980	$12,198.55[3]
1959	$ 4,800	$ 3,855.80	1981	$12,930.46[4]
1960	$ 4,800	$ 4,007.12	1982	$13,706.29
1961	$ 4,800	$ 4,086.76	1983	$14,528.67
1962	$ 4,800	$ 4,291.40	1984	$15,400.39
1963	$ 4,800	$ 4,396.64	1985	$16,324.41
1964	$ 4,800	$ 4,576.32	1986	$17,303.88
1965	$ 4,800	$ 4,658.72	1987	$18,342.11
1966	$ 6,600	$ 4,938.36	1988	$19,442.64
1967	$ 6,600	$ 5,213.44	1989	$20,609.19
1968	$ 7,800	$ 5,571.76	1990	$21,845.75
1969	$ 7,800	$ 5,893.76	1991	$23,156.49
1970	$ 7,800	$ 6,186.24	1992	$24,545.88
1971	$ 7,800	$ 6,497.08	1993	$26,018.63
972	$ 9,000	$ 7,138.80	1994	$27,579.75
973	$10,800	$ 7,580.16	1995	$29,234.54
974	$13,200	$ 8,030.76	1996	$30,988.61
975	$14,100	$ 8,630.92	1997	$32,847.92
976	$15,300	$ 9,226.48	1998	$34,818.80
977	$16,500	$ 9,779.44	1999	$36,907.93
978	$17,700	$10,556.03	2000	$39,122.41
979	$22,900		2001	$41,469.76
980	$25,900		2002	$43,957.95

Nage bases established by Social Security Administration; future ncreases based on automatic escalator provision.
\ssumed growth of 8 percent.
\ssumed growth of 7 percent.
\ssumed growth of 6 percent for remaining years.

OURCE: "DETERMINATION OF PIAs AND BENEFIT MOUNTS," SOCIAL SECURITY PUBLICATION TN 4788, ECEMBER 1979

er. When applied to the monthly average of e indexed earnings, (referred to as AIME), the efit formula yields a worker's primary insur- amount (PIA), on which social security bene- are based.

omputation of the SBP offset is essentially a -step process:

Index the member's covered wages.
Compute average indexed monthly earnings.
Compute the primary insurance amount.
Compute the SBP offset.

ach of these four steps is discussed below.

worker's covered wages (including military wage credits)* are indexed to the second year prior to the benchmark year (the year a worker reaches age 62, becomes disabled, or dies) rather than to the first year of entitlement to social security benefits. The second prior year is used because this is the most recent year for which average wage data necessary to index earnings are available.

Determining indexed wages

Indexed earnings for a given year equal the product of a worker's actual covered earnings in that year multiplied by the ratio of average wages in the index year to the average wages in the year being indexed. A worker can index his wages to any year from a 1979 benchmark year (the first year subject to the 1977 indexing provisions) through a 2004 benchmark year by using the above formula and the data provided in Figure 1. If, for example, a worker reaches age 62 in 1980, his benchmark is 1980 and his index year is 1978. This worker would calculate his indexed wages for 1966 by dividing his average earnings for 1978 (say, $10,556.03) by his average earnings for 1966 ($4,938.36) and then multiplying this product (2.138) by his actual covered wages for 1966 ($6,000). In this example, his indexed earnings for 1966 would amount to $12,828.

Members should note that although indexed wages can and normally will exceed the social security maximum wage base for a given year, actual covered earnings cannot. Also, until a benchmark year is achieved, the indexing of a given year's covered wages will change annually. For example, indexed to 1995, the $6,000 of the preceding example would amount to indexed wages of $35,520 ($29,234.54 divided by $4,938.36, or 5.92, multiplied by $6,000).

Using the data from Figure 1, Figure 2 (p. 44) indexes maximum covered social security wages for the years 1957 through 1980 to both 1978 and 1995. The 1978 indexed data are relevant to any retiree whose benchmark year is 1980, and a member who retired in 1980 can also use them to estimate

*In 1957, military personnel began receiving free wage

Figure 2. Maximum covered Social Security wages for the years 1957 through 1980 indexed to both 1978 and 1995 (assuming the retiree reaches age 62 in 1997)

1978 index year				1995 index year			
Year	Index	FICA wages	Indexed wages	Year	Index	FICA wages	Indexed wages
1957	2.899	$ 4,200	$12,175.80	1957	8.028	$ 4,200	$33,717.60
1958	2.873	$ 4,200	$12,066.60	1958	7.958	$ 4,200	$33,423.60
1959	2.738	$ 4,800	$13,142.40	1959	7.582	$ 4,800	$36,393.60
1960	2.634	$ 4,800	$12,643.20	1960	7.296	$ 4,800	$35,020.80
1961	2.583	$ 4,800	$12,398.40	1961	7.153	$ 4,800	$34,334.40
1962	2.460	$ 4,800	$11,808.00	1962	6.812	$ 4,800	$32,697.60
1963	2.401	$ 4,800	$11,524.80	1963	6.649	$ 4,800	$31,915.20
1964	2.307	$ 4,800	$11,073.60	1964	6.388	$ 4,800	$30,662.40
1965	2.266	$ 4,800	$10,876.80	1965	6.275	$ 4,800	$30,120.00
1966	2.138	$ 6,600	$14,110.80	1966	5.920	$ 6,600	$39,072.00
1967	2.024	$ 6,600	$13,365.00	1967	5.608	$ 6,600	$37,012.80
1968	1.895	$ 7,800	$14,781.00	1968	5.247	$ 7,800	$40,926.60
1969	1.791	$ 7,800	$13,969.80	1969	4.960	$ 7,800	$38,688.00
1970	1.706	$ 7,800	$13,306.80	1970	4.726	$ 7,800	$36,862.80
1971	1.625	$ 7,800	$12,675.00	1971	4.500	$ 7,800	$35,100.00
1972	1.480	$ 9,000	$13,320.00	1972	4.098	$ 9,000	$36,882.00
1973	1.393	$10,800	$15,044.40	1973	3.857	$10,800	$41,655.60
1974	1.314	$13,200	$17,344.80	1974	3.640	$13,200	$48,048.00
1975	1.223	$14,100	$17,244.30	1975	3.387	$14,100	$47,765.70
1976	1.444	$15,300	$17,503.20	1976	3.169	$15,300	$48,485.70
1977	1.079	$16,500	$17,803.50	1977	2.989	$16,500	$49,318.50
1978		$17,700	$17,700.00	1978	2.768	$17,700	$49,011.30
1979		$22,900	$22,900.00	1979	2.564	$22,900	$58,715.60
1980		$25,900	$25,900.00	1980	2.397	$25,900	$62,082.30
		Total	$354,678.20				$967,903.10

the social security offset to his spouse's SBP annuity at the time he retired. The 1995 indexed data are relevant to any retiree whose benchmark year is assumed to be 1997.

Working out a member's average indexed monthly earnings, or AIME, is the second step in computing the SBP offset. These earnings are determined by dividing the total indexed wages by the total number of relevant months. The total relevant months include all years after 1950 (or after age 21, if later) and up to the benchmark year, when the worker reaches age 62, becomes disabled, or dies. Neither the index year *per se* nor the year immediately preceding the benchmark year is indexed, and the 5 years with the lowest earnings are excluded from the computation period. For SBP purposes, the total indexed wages includes all covered military earnings (including

In the event of death or disability prior to age 62, the computation period remains the same as if the retiree had actually reached age 62. This provision reduces the SBP offset for eligible survivors of members who do not reach age 62.

Several examples should prove helpful in understanding how the SBP computation period is derived. Consider an individual who turns 21 in 1956. Forty years will elapse between 1957, the year after he turns 21, and 1997, the year he will be 62 years old. Less the 5 years of lowest indexed or unindexed earnings, the computation period would amount to 35 years for both SBP and social security. Notably, this period would remain the same for the SBP determination even if the person died before age 62. But if this individual died in 1985, his social security computation period would be

regarding growth of average wages

Benchmark year	$180 base	$1,085 base	Benchmark year	$180 base	$1,085 base
1979	$180[1]	$1,085[1]	1992	$402	$2,424
1980	$194[1]	$1,171[1]	1993	$426	$2,569
1981	$210[2]	$1,265[2]	1994	$452	$2,723
1982	$225	$1,354	1995	$479	$2,886
1983	$239	$1,435	1996	$508	$3,059
1984	$253	$1,521	1997	$539	$3,243
1985	$268	$1,612	1998	$570	$3,438
1986	$284	$1,709	1999	$604	$3,644
1987	$301	$1,812	2000	$640	$3,863
1988	$319	$1,921	2001	$678	$4,095
1989	$338	$2,036	2002	$719	$4,341
1990	$358	$2,158	2003	$762	$4,601
1991	$379	$2,287	2004	$808	$4,877

[1] Actual bend points.
[2] Assumed growth of 6 percent for remaining years.

etermining a worker's primary insurance unt—the next step in calculating the SBP off--is a matter of applying a benefit formula to d points" in the worker's average indexed thly earnings. For a worker whose benchmark is 1979, for example, his primary insurance unt is the sum of 90 percent of the first $180 of IE, 32 percent of AIME over $180 and through 85, and 15 percent of AIME over $1,085.

e same percentages apply to benchmark years 1979, but bend points are adjusted annually d on the change in average wages for the index . Thus, bend points for the 1980 benchmark were adjusted for the 7.941 percent growth in age wages in 1978, so a worker's PIA for that hmark year becomes the sum of 90 percent of irst $194 of AIME, 32 percent of AIME over and through $1,171, and 15 percent of AIME $1,171.

gure 3 presents possible growth in bend points certain economic assumptions concerning ent and future growth of average wages. The eral Register publishes actual growth in average

Though a military member must decide whether he will participate in the SBP shortly before he retires, at that point he can only estimate both his PIA and the SBP offset attributable to his covered military earnings. These estimates will change over time due to changes in bend points and to indexing of covered wages to the second year prior to the benchmark year. Moreover, the benchmark year, *not* the year of retirement from the military, determines both social security benefits and any offset to the SBP annuity based on those benefits. Only when a retiree has attained his benchmark year is the actual SBP offset known. The following hypothetical cases illustrate the computations involved.

Assume a military member retires in 1980 and has had maximum covered military wages from 1957 through 1980. At the point of retirement, he could estimate his primary insurance amount at approximately $382.80, or the summation of $174.60 and $208.15. The figure of $174.60 represents 90 percent of the first $194 of the servicemember's average indexed monthly earnings (this $194 figure assumes the aforementioned adjustment to the

$208.15 is derived through a series of calculations, beginning with dividing $354,678.20, the individual's total indexed wages attributable to military service (see Figure 2), by 420 months, which equals his 35 years of total relevant service; this total of $844.47 is then reduced by $194 and in turn multiplied by 32 percent.

A dependent widow's social security benefit is always some percentage of her husband's PIA; her age at the time she applies for benefits determines the percentage payable, which does not change thereafter. For example, if the above member's widow is 62 at the time she applies, her benefit will equal 82.9 percent of her husband's PIA. At the point of retirement, then, the retiree can estimate the SBP offset—that is, the amount by which his widow's social security benefits will offset her SBP annuity—by multiplying the above PIA $382.80 by 82.9 percent. However, that amount of $317.30 is an estimate of the SBP offset only at the point of retirement and will change over time until the retiree reaches his benchmark year. Also, as indicated earlier, it cannot exceed 40 percent of the SBP annuity.

Another example will help show just how tentative such an estimate as the preceding one is. Since a military member does not normally retire at age 62 (a benchmark year), the following scenario is probably a fairly realistic one:

- A military member retires in 1980 at age 45 with maximum covered wages from 1957 through 1980.
- The retiree dies in the year 2000 at age 65.
- The spouse becomes 62 in 2000.
- Inflation from 1995 to 2000 is 6 percent annually.

Since the retiree becomes 62 in 1997, his index year would be 1995 (the second year prior to the benchmark year) and the calculations for his PIA would be as follows:

Total indexed wages attributable to military service = $967,903.10 (see Figure 2).

AIME = $967,903 ÷ (35 years × 12 months) = $2,304.53.

PIA = .9(538) + .32 (2,304.53 − 538) (see Figure 3 for change in bend points).

PIA = 484.20 + 565.29.

to social security benefits at age [illegible] PIA on which her benefits are based has been indexed to 1995. Adjustments to those benefits for cost-of-living increases begin with the benchmark year (1997) and continue each year thereafter. Her social security benefit based on her husband's military earnings would thus be 82.9 percent of $1,049.50 ($870) plus 3 years of cost-of-living adjustments (assumed to be 6 percent annually), which totals $1,036.20.

This is also the initial amount of the SBP offset, to be adjusted in future years for any subsequent cost-of-living increases. Again, however, this SBP offset may not exceed 40 percent of the SBP annuity.

Of course, this study cannot address all possible retirement situations. Retirement grades, length of active-duty service, pay grades, and the ages of the member and his spouse are all variables. Other complicating factors include dependent children, divorce, death of a spouse, and remarriage. We hope that the following two hypothetical cases will help the reader better understand the various interactions and changes over time which affect a member's retirement pay, SBP costs and benefits, and social security benefits.

For simplicity sake, the two examples assume a 6 percent annual growth in both average wage and cost of living from 1980 *ad infinitum*. These economic assumptions affect future levels of military retirement benefits, SBP costs, SBP benefits, and social security benefits. The reader may wish to use different economic assumptions.

An SBP scenario: the lieutenant colonel

This example involves the retirement in 1980 of a lieutenant colonel with over 21 years' service for both pay and retirement purposes; we assume that this member:

- Entered active military duty on 1 April 1959.
- Retired effective 1 September 1980.
- Receives retirement pay based on the 1 October 1978 pay scale (as adjusted for cost of living).
- Elects to take the maximum SBP.
- Is age 45 at retirement, reaches age 62 in 1997, and has a spouse who reaches age 62 in 2000.

Figure 4 shows the growth in the colonel's retire-

Year	(1995 index year)	wages[1]	wages	Year	pay[2]	pay) [3]	($960.90 base) [3]
1957	8.028	0	0	1999	$ 4,399		
1958	7.958	0	0	2000	$ 4,663	$2,419.50	$1,458.60
1959	7.582	$ 3,200 (est.)	$24,262.40	2001	$ 4,943	$2,564.70	$1,546.10
1960	7.196	$ 4,200 (est.)	$30,643.20	2002	$ 5,240	$2,718.70	$1,639.00
1961	7.153	$ 4,800	$34,334.40	2003	$ 5,554	$2,882.00	$1,737.50
1962	6.812	$ 4,800	$32,697.60	2004	$ 5,887	$3054.70	$1,841.50
1963	6.649	$ 4,800	$31,915.20	2005	$ 6,240	$3,237.90	$1,951.90
1964	6.388	$ 4,800	$30,662.40	2006	$ 6,614	$3,432.00	$2,068.80
1965	6.275	$ 4,800	$30,120.00	2007	$ 7,011	$3,637.70	$2,192.70
1966	5.920	$ 6,600	$39,072.00	2008	$ 7,432	$3,856.00	$2,324.40
1967	5.608	$ 6,600	$37,012.80	2009	$ 7,878	$4,087.60	$2,464.00
1968	5.247	$ 7,800	$40,926.60	2010	$ 8,351	$4,332.90	$2,611.90
1969	4.960	$ 7,800	$38,688.00	2011	$ 8,852	$4,593.10	$2,768.80
1970	4.726	$ 7,800	$36,862.80	2012	$ 9,383	$4,868.60	$2,934.80
1971	4.500	$ 7,800	$35,100.00	2013	$ 9,946	$5,160.70	$3,110.90
1972	4.098	$ 9,000	$36,882.00	2014	$10,543	$5,470.30	$3,297.50
1973	3.857	$10,800	$41,655.60	2015	$11,176	$5,798.70	$3,495.50
1974	3.640	$13,200	$48,048.00	2016	$11,847	$6,146.80	$3,705.40
1975	3.387	$14,100	$47,766.70	2017	$12,558	$6,515.90	$3,928.00
1976	3.169	$15,300	$48,485.70	2018	$13,311	$6,906.90	$4,163.70
1977	2.989	$16,500	$49,318.50	2019	$14,110	$7,321.10	$4,413.30
1978	2.769	$17,700	$49,011.30	2020	$14,957	$7,760.50	$4,678.20
1979	2.564	$22,900	$58,715.60				
1980	2.397	$19,000 (est.)	$45,543.00				
		Total	$867,713.80				

[1]Except for 1959 and 1960, covered wages are the Social Security maximum.
[2]Assumed cost-of-living increase of 8 percent effective September 1980, resulting in initial retirement pay of $1,454 per month.
[3]Computations are based on retirement pay and SBP offset at the end of the preceding year.

mark year), his social security benefits are indexed to 1995. The PIA computation at this point is as follows:

Total indexed wages attributable to military service = $867,713.80.
AIME = $867,713.80 ÷ (35 years × 12 months) = $2,065.99.
PIA = .9(538) + .32 (2,065.99 − 538).
PIA = 484.20 + 488.96.
PIA = $973.20.

If his spouse applies for social security benefits when she reaches 62 (year 2000), her benefits in that year will be calculated as follows:
Member's PIA (indexed to 1995) = $973.20.
Spouse's benefit at age 62 (82.9 percent of member's PIA) = $806.80.
Beginning with the benchmark year (1997), benefits based on the member's PIA are adjusted for cost-of-living increases; consequently, given the assumption of a 6 percent annual cost-of-living increase, the spouse's benefit will actually be $806.80 times 1.91 (3 years at 6 percent), or $960.90.

Once the member dies and the SBP goes into effect, his widow's SBP payments (a maximum of 55 percent of his retirement pay) will be offset by that portion of any social security benefit she receives which is attributable to his military service. Should the member die in year 2000, the $960.90 social security benefit computed above would be the initial offset. Both future offsets and future SBP payments would be adjusted annually for any cost-of-living increases.

Indexed Social Security benefits				Growth in retirement pay				
Year	Index (2002 index year)	FICA wages[1]	Indexed wages	Year	Retirement pay[2]	SBP (55% of retirement pay)	SBP less offset ($1,061.40 base)	Net SBP based on maximum 40 percent offset ($.91)
1957	12.071	0	0	2006	$2,886	**[3]	**[3]	
1958	11.965	0	0	2007	$3,059	$1,587.30	$ 525.90	$ 952.40
1959	11.400	0	0	2008	$3,243	$1,682.50	$ 557.40	$1,009.50
1960	10.970	$ 1,100	$12,067.00	2009	$3,438	$1,783.70	$ 591.10	$1,070.20
1961	10.756	$ 2,400	$25,814.40	2010	$3,644	$1,890.90	$ 626.70	$1,134.50
1962	10.243	$ 2,500	$15,607.50	2011	$3,863	$2,004.20	$ 664.10	$1,202.50
1963	9.998	$ 3,000	$29,994.00	2012	$4,095	$2,124.70	$ 704.20	$1,274.80
1964	9.606	$ 3,300	$31,699.80	2013	$4,341	$2,252.30	$ 746.60	$1,351.40
1965	9.436	$ 3,400	$32,082.40	2014	$4,601	$2,387.60	$ 791.60	$1,432.60
1966	8.901	$ 3,700	$23,933.70	2015	$4,877	$2,530.60	$ 838.80	$1,518.40
1967	8.432	$ 4,300	$36,257.60	2016	$5,170	$2,682.40	$ 889.10	$1,609.40
1968	7.889	$ 4,600	$36,289.40	2017	$5,480	$2,843.50	$ 942.60	$1,706.10
1969	7.458	$ 4,900	$36,544.20	2018	$5,809	$3,014.00	$ 999.00	$1,808.40
1970	7.106	$ 5,900	$41,925.40	2019	$6,158	$3,195.00	$1,059.10	$1,917.00
1971	6.766	$ 6,300	$42,625.80	2020	$6,527	$3,386.90	$1,122.80	$2,032.10
1972	6.162	$ 6,900	$42,517.80	2021	$6,919	$3,589.90	$1,190.00	$2,153.90
1973	5.799	$ 7,900	$45,812.10	2022	$7,334	$3,805.50	$1,261.60	$2,283.30
1974	5.474	$ 8,600	$47,076.40	2023	$7,774	$4,033.70	$1,337.20	$2,420.20
1975	5.093	$ 9,000	$45,837.00	2024	$8,240	$4,275.70	$1,417.40	$2,565.40
1976	4.764	$10,000	$47,640.00	2025	$8,734	$4,532.00	$1,502.20	$2,719.20
1977	4.495	$10,400	$46,748.00	2026	$9,258	$4,803.70	$1,592.10	$2,882.10
1978	4.164	$12,300	$51,217.30	2027	$9,813	$5,091.90	$1,687.60	$3,055.10
1979	3.856	$13,300	$51,284.80					
1980	3.604	$ 9,400	$33,877.60					
		Total	$795,852.10					

[1] All amounts are estimates and include military wage credits; maximum covered Social Security wages were not met in any year.
[2] Assumed cost-of-living increase of 8 percent effective September 1980, resulting in initial retirement pay of $636 per month.
[3] Computations are based on retirement pay and SBP offset at the end of the preceding year.

If the member dies at some point after year 2000, the SBP offset begins at that point. Figure 4 gives both the gross (55 percent) and the net (55 percent less offset) SBP payments for years 2000 through 2020.

In year 2000 the SBP annuity, less offset, is 60.3 percent of the gross SBP amount (55 percent of the member's retired pay). In other words, the social security offset is 39.7 percent, which is less than the 40 percent maximum offset established by Senate Act 91. Since both the gross SBP annuity and its social security offset will be adjusted annually for the same cost-of-living increases, this 60.3/39.7 percent ratio will continue.

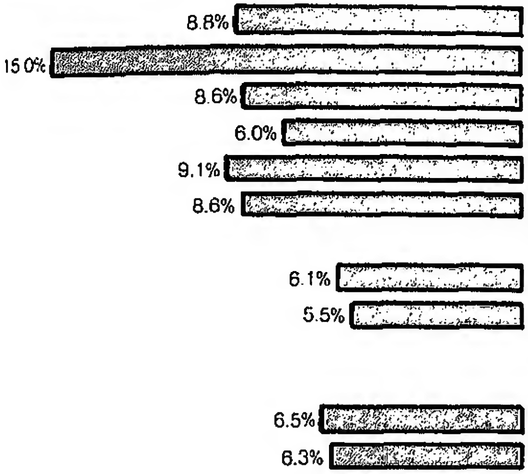
Thus the statutory provision that a widow not receive less than 60 percent of the SBP annuity to which she is entitled does not really benefit this member's widow. In fact, it will not benefit most senior officers (lieutenant colonels and above) who elect maximum or near maximum SBP coverage for their spouses. Conversely, as the following example involving the master sergeant shows, most enlisted and junior officer retirees will benefit from the 40 percent maximum offset provision of Senate Act 91.

An SBP scenario: the master sergeant

In our second example, a master sergeant retires in 1980 with more than 20 years' service for both pay and retirement purposes; this retiree:

- Entered active military duty on 1 July 1960.

Inflation does not affect all commodities equally. This figure depicts the compounded rate of increase experienced between 1962 and 1979 and projects future costs for various items and future earnings for two types of wage earners through 1999.



COMPOUNDED RATE OF INCREASE (1962-1979)		1962	1979	Assuming same rate of increase 1989	Assuming same rate of increase 1999
	WHAT THINGS MAY COST ($)				
8.8%	One-family house	19,300	68,300	158,784	368,975
15.0%	Social Security deduction	150	1,403	3,561	6,770
8.6%	Monthly electric bill	8	30	68	156
6.0%	Gallon of gasoline	0.31	0.79	1.41	2.53
9.1%	Daily NEW YORK TIMES	0.05	0.20	0.48	1.14
8.6%	Postage stamp	0.04	0.15	0.34	0.78
	WHAT YOU MAY EARN ($)				
	In-house attorney				
6.1%	Gross earnings	16,440	42,318	76,502	138,302
5.5%	Aftertax earnings	12,872	30,113	41,860	56,878
	. . . Inflation-adjusted	29,577	30,113	23,155	17,404
	. . . As percent of gross	78%	71%	55%	41%
	Production worker				
6.5%	Gross earnings	5,021	13,850	25,998	48,802
6.3%	Aftertax earnings	4,420	11,795	19,698	30,615
	. . . Inflation-adjusted	10,156	11,795	10,494	8,688
	. . . As percent of gross	88%	85%	76%	63%

* Assumptions: married taxpayer; joint return; two dependent children; standard deduction; no change in 1979 tax structure for subsequent years; gross earnings less net tax liability, state and local income taxes; Social Security tax for 1989 and 1999 from legislation in effect.

SOURCE: "STATISTICAL SPOTLIGHT: COMPOUNDING INFLATION," *FORBES*, JUNE 11, 1979, p. 108.

- Retired effective 1 September 1980.
- Receives retirement pay based on the 1 October 1978 pay scale (as adjusted for cost of living).
- Elects the maximum SBP.
- Is age 38 at retirement, reaches age 62 in 2004, and has a spouse who reaches age 62 in 2007.

Figure 5 shows the growth in the sergeant's retirement pay given a 6 percent annual cost-of-living increase. Since the retiree becomes 62 in year 2004 (benchmark year), his social security benefits are indexed to year 2002, and the PIA computation at this point is as follows:

Total indexed wages attributable to military service = $795,852.10.
AIME = $795,852.10 ÷ (35 years × 12 months) = $1,894.89.
PIA = .9(808) + .32(1,894.89 − 808).
PIA = 727.30 + 347.80.
PIA = $1,075.00.

If his spouse applies for social security benefits when she reaches 62 (year 2007), her benefits in that year will be computed as follows:
Member's PIA (indexed to 2002) = $1,075.00.
Spouse's benefit at age 62 (82.9 percent of member's PIA) = $891.20.

Beginning with the benchmark year (2004), benefits based on the member's PIA are adjusted for cost-of-living increases; consequently, given the assumption of a 6 percent annual cost-of-living increase, the spouse's benefit will actually be $891.20 times 1.91 (3 years at 6 percent), or $1,061.40.

Once the member dies and the SBP goes into effect, his widow's SBP payments (a maximum of 55 percent of his retirement pay) will be offset by that portion of any social security benefit she receives which is attributable to his military service. Should the member die in year 2007, the $1,061.40 social security benefit computed above would be the initial offset. But because Senate Act 91 now limits

the SBP offset to 40 percent of the SBP annuity, the initial SBP offset would actually be 40 percent of $1,587.30 (the amount of the SBP annuity as per Figure 5), or $634.90. Both future offsets and future SBP payments would be adjusted annually for cost-of-living increases.

If the member dies at some point after year 2007, the SBP offset begins at that point. Figure 5 gives both the gross and net SBP payments for years 2007 through 2027.

In year 2007 the SBP annuity, less offset, is 33.1 percent of the gross SBP amount (55 percent of the member's retired pay). This 66.9 percent offset thus exceeds the 40 percent maximum established by Senate Act 91 and, as noted above, the social security offset is therefore reduced to $634.90. Since both the gross SBP annuity and its social security offset will be adjusted annually for the same cost-of-living increases, this 66.9/33.1 percent ratio will continue, as will reductions to the SBP offset.

Whatever the assumptions used, projected future payments to retirees and their spouses are likely to appear astronomical. For example, if the inflation rate is 6 percent per annum, a lieutenant colonel retiring in 1980 at $1,454 dollars a month will receive $4,663 in year 2000 and $8,351 in year 2010; his spouse will receive a net SBP payment of $1,458.60 in year 2000 and $2,611.90 in year 2010 (see Figure 4). However, these figures reflect then-year dollars; were payments stated in constant 1980 dollars, all future payments would approximate those established in 1980.

Obviously, prices and wages are not constant. The rise in the consumer price index from 100 in 1967 to 239.8 by the end of March 1980, for example, equates to roughly a 7½ percent annual rate of inflation. To put this into perspective, a 6 percent annual growth in cost of living and average wages, as assumed in this study, would double prices and wages in roughly 12 years and treble them in less than 19 years.

Moreover, inflation does not affect all items equally, as is clear from Figure 6 (p. 49), which also graphically illustrates the effects of compounding inflation. The projected price for a gallon of gas in 1989 is already nearly here. Thus "inflated" future retirement and SBP benefits will

tirement system sometimes gloss over. For ex ple, in an April 21, 1980, article entitled " Skyrocketing Costs of Federal Pensions," *News and World Report* indicated that by the 2000, the number of military retirees would ris nearly 36 percent, while associated pension c would increase 175 percent. What the article not point out is that these increased benefits re roughly a 3.5 percent annual rate of inflation.

The Survivor Benefit Plan of itself is relati straightforward. The designated beneficiary ceives 55 percent of some selected base amount we have tried to show in the above discussion, h ever, a major complexity enters when the survi spouse becomes entitled to social security ben based on the retiree's covered military earnings most instances, this social security entitlement be offset (deducted from the widow's S annuity), and inflation complicates the issue ther.

How does one project what future SBP ann and social security amounts will be? This study shown how to calculate social security benefits how to project them, and the resulting SBP off into the future. Such projections require econo assumptions concerning future inflation rates changes in average wages. Even more critical, must project his own longevity and that of his d ignated beneficiary. In other words, when make the SBP decision, you bet your life. DM

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Increased productivity in processing travel claims can cut administrative costs significantly

U.S. General Accounting Office, Washington, DC (AFMD-81-18, January 19, 1981). Request copies of GAO reports from: U.S. General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

Because of congressional concern over the high cost of federal employees' travel, GAO examined productivity in processing claims for temporary duty travel completed within the United States during 1978 and 1979. GAO found that processing claims may be costing $400 billion too much each year, or 16 percent of the total amount spent for government travel annually.

According to GAO, the General Services Administration, which is responsible for regulating civilian employees' travel, should replace the present system of providing payment up to predetermined ceilings at cities designated as high cost. Because GSA has named an increasing number of localities as high-cost areas, the volume and processing of high-rate vouchers has risen. In GAO's estimate, half as much money would be spent using a two-tier, lodgings-plus (other expenses) method, which sets one ceiling for more expensive areas and another for all others. A two-tiered method would eliminate much of the detailed itemizing and documentation that are time-consuming and more prone to error and consequently a costly administrative problem under the current processing system.

GAO found actual productivity at all but one of the pay centers it visited to be very low. The report recommends that heads of appropriate departments establish computer examination of travel vouchers and other forms of automation where they are cost effective and that they use statistical sampling in auditing voucher processing. Eliminating redundant, overly detailed supervisory reviews and typing of already legible handwritten vouchers would also save money, according to GAO.

Finally, GAO urged revision of the reimbursement method for enroute travel. It judged GSA's proposed revision too complicated, difficult to administer, and costly. GAO prefers paying full per diem for each day that requires lodgings and one half of the meal and

GAO advocated adoption of the same reimbursement methods for military personnel traveling within the United States as for civilians.

Preliminary analysis of military compensation systems in the United States and five other countries

U.S. General Accounting Office, Washington, DC (FPCD-81-21, December 31, 1980). Request copies of GAO reports from: U.S. General Accounting Office, Document Handling and Information Services Facility, P.O. Box 6015, Gaithersburg, MD 20760.

The General Accounting Office's comparison of the United States' military compensation system with those of Australia, Canada, France, West Germany, and the United Kingdom revealed major differences in pay systems and practices. Most notably, U.S. pay rates, especially when expressed in terms of purchasing power, are well below those of other volunteer force countries. In its report, GAO outlines several foreign pay policies and practices that may offer potential for use in the United States.

The three foreign countries that maintain their armed forces on a volunteer basis (Australia, Canada, and the United Kingdom) have discarded pay and allowance structures similar to those of the United States. They have opted instead for a taxable salary system and have subdivided their respective systems into different pay tracts, each linked to a different part of the civilian sector. Both the Australian and United Kingdom systems also include "X factor" payments to compensate for the disadvantages and rigors of military life. All three foreign countries, contrary to U.S. practice, tax the equivalent of quarters and subsistence allowances. While all five foreign countries studied provide full medical care for active-duty military personnel, they generally provide more limited care for dependents and retired personnel than the United States does.

GAO found that the United States, along with France, has the largest proportion of military to civilian population. The United Kingdom, on the other hand, has the highest proportion of defense expenditures to gross

France, respectively. The report states that, as in the U.S., pay at the E-1 level in those foreign countries with volunteer services has increased at a rate greater than civilian pay since 1976 but less than the rate of inflation.

Comparison of pay at the E-5 and O-4 levels for all six countries showed that as of October 1, 1980, U.S. military personnel at these levels generally had less purchasing power than their foreign counterparts. In the United Kingdom, pay for new E-5s is almost double that in the United States. Broadly speaking, the living standard of U.S. personnel at the O-4 and E-5 levels is closest to that of their French counterparts.

GAO also identified several concepts which might prove useful in efforts to overcome current manpower problems in the United States:

- **X factor.** A study of the Australian and United Kingdom "X factor" could identify both the methods used to define elements of the factor and methods to measure its effectiveness.
- **Pay system linked to civilian economy.** The major thrust of research into the possibility of linking military pay to civilian sector pay would be to determine the procedures used to subdivide ranks into occupational groups and link military salaries to private economy wages, and to determine whether pay grouping and linkage of military pay to the civilian economy have prevented loss of skilled technicians.
- **Salary system.** A study of the Australian, Canadian, and United Kingdom salary systems, which differ from the U.S. combination of base pay, quarters and subsistence allowances as well as tax advantages on these allowances, would determine whether salary systems have had a favorable impact on recruiting, motivational, and retention goals.
- **Differential pay rates for longer term enlistments.** An evaluation of United Kingdom and French inducement programs might suggest measures that would help the U.S. meet its need for extended service from high-quality personnel.
- **Relative time personnel remain at similar pay levels.** The amount of time military personnel remain at pay levels varies from country to country. Analysis of these variances could indicate what impact time in service and grade have on the pay of military personnel.
- **Special and premium pays.** The foreign countries studied offer a range of special and premium pay to attract and retain military personnel to specific duties and occupations such as submarine duty and the health professions. Study of select occupations which qualify for such pay could indicate what effect the com- pensation has on meeting desired manning levels

Resources for defense: a review of key issues for fiscal years 1982-1986

The Congress of the United States, Congressional Budget Office, January 1981. Request copies of CBO studies from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

At the request of the House Budget Committee the Congressional Budget Office reviewed a selection of program alternatives illustrating how different approaches to allocating increases among competing defense requirements would affect defense budgets through 1985. As the point of departure for its study, CBO used the "baseline" projection of the defense budget for all programs approved by Congress for fiscal 1981. The programs reviewed were generally categorized according to short-term (under five years) or long-term (over five years) effects on U.S. defense spending.

Largely because of improved Soviet missile accuracy, according to CBO, debates on defense spending are likely to hinge around these key issues:

- Are improvements needed for U.S. strategic forces?
- Are improvements needed for U.S. conventional forces particularly to enhance "readiness?"
- How should resources be allocated between conventional forces supporting NATO and those required for operations outside Europe?
- What are the prospects for maintaining a high-quality all-volunteer force?

In its study of the first issue, CBO concluded that improvements are needed but that few near-term measures are truly available. It pointed to increasing the B-52 peacetime, day-to-day alert rates as the most likely option for improving strategic force capability, since the increases could be achieved almost immediately and at little extra cost by adding on bomber crews and maintenance personnel. The readiness of alert bombers for immediate take-off enhances their chances of surviving a surprise attack. Other near-term options, such as mod-

fying the FB-111 airplane in order to double its bomb capacity or building the large numbers of Minuteman III missiles required to improve strategic capabilities, would involve prohibitive costs. The cost, plus the need for congressional waivers of environmental and procurement regulations, make it unlikely that either option could be available within even ten years. Also, opinions in Congress and the military concerning the two alternatives vary widely because of differing perceptions about the balance of forces between the U.S. and the Soviet Union.

Experts disagree less about the need for longer-term modernization, although key questions remain about one such improvement, the MX missile system, which is currently under full-scale development. CBO notes that long-term costs, already great, could increase even further if the Soviet Union augments its own strategic force levels in response to our missiles. Moreover, environmental problems associated with the system, which involve withdrawing large amounts of land and water from public use, while adding thousands of people, could seriously disrupt local life.

Accelerating the Trident II submarine-launched ballistic missile program is another long-range alternative for improving U.S. strategic forces. It is already funded over the next eight years and might provide a hedge against delays in the MX missile development. Other strategic force improvements studied by CBO related to the size and composition of tanker planes for refueling strategic aircraft over the next few years, but CBO analysis had not proceeded far enough to suggest the most cost-effective improvement here.

In contrast to improvements available for strategic programs, significant near- and long-term enhancements already exist for U.S. conventional force readiness, both within and outside of NATO. The current defense baseline includes a number of programs for conventional NATO-related forces. Many of these, for example, the POMCUS, or Prepositioned Overseas Materiel Configured to Unit Sets Program, focus on reinforcing NATO rapidly early in a war; however, CBO analysts considered this program underfunded. Other possible near-term additions to the conventional forces baseline budget include spare parts acquisition to support tactical Air Force readiness, homeporting arrangements in the Mediterranean to improve naval force readiness, and two fully supported armored divisions to buy the time needed to establish a defense of Europe.

Long-term enhancement of conventional forces could be achieved by adding five fully supported armored divisions to defend against Warsaw Pact nations and by acquiring new warships, including three carriers. CBO emphasized that the effectiveness of such programs depends on the allies' commitment to accept their fair share of any force expansions, even if it means going beyond the 3 percent annual real growth in defense spending agreed upon in 1977. Without such commitment, the U.S. would face difficult choices between larger NATO-related increases and changes in emphasis between NATO and non-NATO requirements.

Alternatives for addressing the third issue are largely matters of funding for operating, maintaining and manning the Rapid Deployment Force, which is currently assigned to the Persian Gulf. But additional firepower and combat support for U.S. troops may be necessary there to counter Soviet operations, thus adding billions to baseline costs. Also, the prepositioning of ships required under the RDF option would take longer than a decade. Other additions to the baseline, depending upon whom the RDF would oppose, could include force level increases, purchase of light-weight armor, and amphibious ships to enable response in Persian Gulf crises that might not include other allied forces; all of these constitute longer-term investments.

In answering the fourth question, CBO indicated that recruiting may be the most crucial issue before Congress in the 1980s. Pay increases already targeted for careerists appear to have reversed negative trends in overall career levels but have done less to improve recruiting. Any expansion in force levels will further increase demands on recruiting, as will declining levels of the youth population. CBO suggested that Congress may wish to ensure the service of more high school graduates by reducing constraints on the number recruited from the lowest-scoring category on the enlistees' entrance examinations.

Another alternative, across-the-board pay increases that keep pace with private sector wages, would involve much greater costs than cash enlistment and reenlistment bonuses targeted at recruiting personnel into specific skill areas. Congress could also consider improving military education incentives and changing military retirement benefits by moving more compensation "up front," that is, earlier in the career pattern.

Thus overall, Congress faces a series of key, interacting decisions on allocating funds for different types of forces and systems and for compensating the personnel that man them. CBO made no recommendations as a result of its review. A subsequent paper will evaluate DoD budget requests for 1982 in light of this report.

DoD to limit sole source

The Department of Defense is putting more competition into its procurement process. In a July 27 memo, Deputy Defense Secretary Frank C. Carlucci instructed senior DoD officials to allow fewer "sole source" contracts, which are awarded to companies without the competitive bidding process. The General Accounting Office has stated that these contracts are a continuing and worsening problem and may waste more than $70 million annually.

In a July 1981 report, the GAO said that as much as $289 million in military procurement contracts were let without competition during FY 1979. Although some of the contracts were properly sole source, many were not. A GAO auditor estimated that 25 to 30 percent of the $289 million could have been saved if the contracts had been awarded competitively. These savings would have amounted to approximately $70 million in FY 1979.

GAO recommended that the Pentagon set goals for reducing sole source awards. DoD's initial reply to the draft report and recommendation said that it would be impracticable to set such goals and monitor them. However, Secretary Carlucci's July memorandum to the service secretaries and senior officials apparently reversed this position. In directing DoD to "establish management objectives for the enhancement of competition," the secretary stated that competition "reduces the costs of needed supplies and services, improves contractor performances, helps to combat rising costs, increases the industrial base and ensures fairness of opportunity for award of government contracts."

While GAO's report dealt solely with contracting for procurement of goods and systems, Secretary Carlucci's memorandum affects contracts in program management, engineering, financial management, legal, supply, maintenance, and other fields as well.

Transportation realignment

Deputy Secretary of Defense Frank C. Carlucci has announced a program to improve transportation management within the Department of Defense. Key concerns of the program are transportation operating efficiencies and deployment planning and management.

Secretary Carlucci has directed the Army and the Navy to plan transfer of sealift cargo and passenger booking and contract administration functions from the Navy's Military Sealift Command to the Army's Military Traffic Management Command. The transfer of functions will enable the Defense Department to capitalize on intermodal, containerized services offered by the transportation industry and should result in reduced annual operating costs as well as a reduced inventory of material in the transportation pipeline.

The new program will also consolidate operational management of defense intermodal container and other dry cargo moving in partial or full shiploads. The Military Traffic Management Command will be responsible for both activities during peace and war, while the Military Sealift Command will continue as the sealift operator and procurement agent and the principal DoD intermediary with the United States merchant marine and the Maritime Administration.

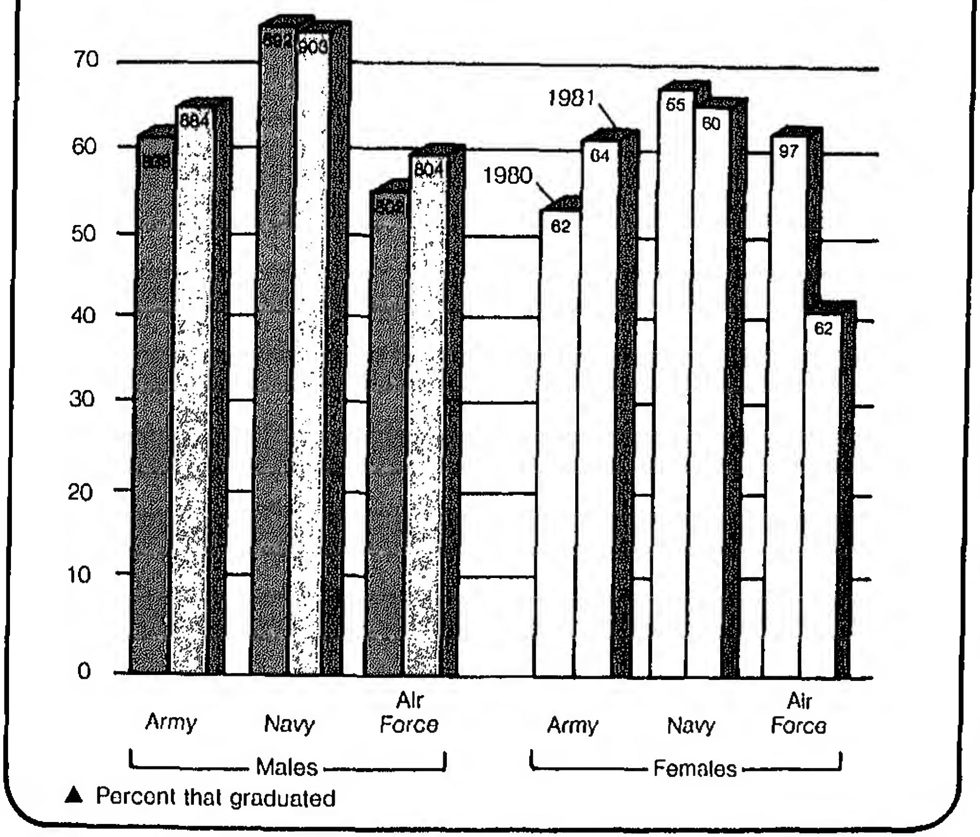
In addition, the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) will work with the Army and the Air Force to develop a plan for improving the management and procurement of domestic passenger transportation services.

To address the other major concern of the program, Mr. Carlucci has asked the Chairman of the Joint Chiefs of Staff to develop a plan to improve deployment planning and management and to strengthen the U.S. Readiness Command's Joint Deployment Agency. The plan is to provide a framework both for performing joint wartime and contingency mobility planning and force deployments and for traffic management. Its purpose is to give cohesion to the support required for wartime deployments and to improve the capability of the transportation system in making a smooth and effective transition from peacetime to wartime operations.

Academy graduation rates

Recently published graduation statistics for the three principal military academies show either increases or only very slight declines in completion rates, save among female graduates at the U.S. Air Force Academy. For the second year in a row, the overall completion rate at the Naval Academy at Annapolis topped that of the other two schools. Although West Point continues to narrow the gap, the Air Force Academy lags behind, largely because of a sharp decline in the rate of women completing the

Graduation rates at the service academies



course of study. The graduating class of 1980 at the Colorado Springs school included almost 62 percent of those women who had entered 4 years earlier, the class of 1981 less than 41 percent.

A principal reason for the increase in female attrition, according to some Air Force Academy officials, is that policy makers paid less attention to the second female freshman class than they did to its predecessor. For example, while female company-grade air training officers supervised the first class of women cadets, mostly male juniors and seniors supervised the second class, thus effectively removing female role models.

Decreased peer support may also help explain the jump in female attrition. Unlike women in the freshman class of 1976, who were physically quartered together, their counterparts in succeeding classes have not been and thus may not have the same feeling of group identity. On the other hand, women at West Point and Annapolis have been billeted throughout the barracks from the beginning.

One step the Air Force Academy has taken to reverse the decline in female graduates is to increase the number of women on the faculty to 34, up from approximately 25. West Point reports 35 women on the faculty, and Annapolis reports 51.

Air Force Academy officials expect that the additional female role models on the faculty will help boost retention rates among female cadets. Moreover, as classes progress, the number of women earning higher cadet ranks and supervisory positions also increases and is likely to have a positive effect on female completion rates as well. In addition, the academy has placed greater emphasis on sexual awareness training.

The dropout rate for women in the class of 1982 at the Air Force Academy now stands at 43 percent; for 1983 graduates, the rate is 38 percent. Male dropout rates for the same classes are 41 and 32 percent, respectively.

Policy panel to advise Weinberger

Secretary of Defense Caspar W. Weinberger has directed the Joint Chiefs of Staff to name a blue-ribbon analysis group in response to the advice of a recently formed congressional group. The members of Congress, known as the Reform Caucus, suggested that the Secretary seek more independent advice on current military policies such as multi-billion-dollar purchases of

super-weapons.

In a memo to General David C. Jones, Chairman of the Joint Chiefs of Staff, Secretary Weinberger asked for a group made up of "bright, articulate thinkers" able to "look at things differently" and to think "with maximum analytical rigor about broad policy and strategy issues." The secretary instructed the chairman to attach the new analysis group to the National War College of the National Defense University, both located at For McNair in Washington.

Mr. Weinberger proposed five analysts and a staff of two, plus employment of outside consultants and "limited use" of students at the National Defense University. He indicated that he and Deputy Defense Secretary Frank C. Carlucci would meet with the group once a month "in free-wheeling, informal, give-and-take sessions." The analysts will serve two years at the pleasure of the defense secretary.

Zip changes delayed

The Department of Defense and the military services will not be using the U.S. Postal Service's new nine-digit zip code until 1983. A portion of the budget reconciliation bill signed by President Reagan on August 13 prohibits all executive agencies from complying with the zip code changes through December 31, 1982.

The U.S. Postal Service has already assigned the lengthened codes to many military installations and has notified them of the new code designations for information purposes only. The reconciliation bill allows the Postal Service to prepare for the new system but forbids implementation before October 1, 1983.

Contractors recognized

Eaton Corporation, AIL Division, recently received top national honors in the Defense Logistic Agency's annual program for recognizing contractor excellence in assisting small, disadvantaged businesses. For the past several years, Eaton's AIL Division has met or exceeded the national average of awards to disadvantaged businesses by an increasing margin; in 1980, it awarded 2.7 percent of its contracts to such businesses, compared to a 1.8 percent average nationwide.

The New York firm was selected from among DoD prime contractors nominated in nine Defense Contract Administration Services Regions for formal recognition. Nominees were evaluated in such areas as providing assistance beyond that required by contract; setting up a program that yielded positive results consonant with national goals; evidence of active support by executive-level personnel; statistical increases in total awards to small, disadvantaged subcontractors; and evidence of managerial, technical, marketing, or financial assistance.

Propper International, Incorporated, a small business located in Puerto Rico, was the recipient of a special award for developing a minority-owned firm into a viable subcontractor. By expanding its production facilities and broadening its production capability, Propper increased revenues from $1.8 million in 1972 to more than $16 million in 1980.

Recruiting goals met

Defense Department figures show that the services achieved 99 percent of their overall recruiting goals through the first nine months of FY 1981. Three of the services met or exceeded their recruitment goals; only the Army fell short of its objective, with 2 percent fewer recruits than projected. Even with a smaller recruiting objective than last year, the Army would have fallen short of this year's goal by 6 percent, had it not been for unexpectedly higher retention rates and increased prior-service enlistments.

By June 30, the services had recruited 21,200 more high school graduates than they did last year. The Army recorded the biggest jump in recruits with high school diplomas—69 percent of its male recruits held diplomas, compared to 40 percent last year. Among male Air Force recruits, 85 percent were graduates, as were 72 and 74 percent of Navy and Marine Corps recruits, respectively. The percentage of women recruits with high school diplomas also increased in all the services.

Recruit quality, as measured by the Armed Forces Qualification Test, likewise improved in all the services. The number of recruits scoring in Category IV—the lowest acceptable category—fell by 21 percent for the Army, 15 percent for the Marine Corps, 4 percent for the Navy, and 1 percent for the Air Force. Category IV now includes 28 percent of Army's recruits, 15 percent of Marine Corps', 13 percent of Navy's, and 7 percent of Air Force's.

Event	Date	Place	Contact
Management Skills for New Women Supervisors in the Public Sector	Dec 14-16	Washington, DC	American Management Associations 135 West 50th Street New York, NY 10020 (212) 246-0800
Executive Effectiveness Course	Dec 14-18 Dec 14-18	Carmel, CA Vero Beach, FL	
Time Management for Public Sector Administrators	Jan 11-13	Boston, MA	
Defense and National Economy in the 1980s	Dec 14-17	Ramat-Aviv Tel-Aviv, Israel	Administrative Coordinator Center for Strategic Studies Tel-Aviv University Ramat-Aviv, Tel-Aviv Israel 69978 (03) 417-560
Hawaii International Conference on System Sciences	Jan 6-8	Honolulu, HI	HICSS-15 Office of Management Programs University of Hawaii 2404 Maile Way, C202 Honolulu, HI 96822 (808) 948-7396
Introduction to Federal Acquisition	Feb 1-4	Washington, DC	Career Planning and Development Programs Graduate School, USDA 356 National Press Building 529 14th Street, NW Washington, DC 20045 (202) 447-7124
Executive Briefing	Feb 4-5	Washington, DC	Special Programs Graduate School, USDA 600 Maryland Avenue, SW Washington, DC 20024 Contact Kathy Grasso (202) 447-3247
Labor Relations for Managers and Executives	Feb 10-12	Washington, DC	
Arbitration Advocacy	Mar 1-3	Washington, DC	
Logistics Engineering and Analysis	Feb 8-12	Los Angeles, CA	SOLE Headquarters Suite 922 303 Williams Avenue Huntsville, AL 35801
Logistics Planning and Management	Mar 16-18	Florida	
A User's Introduction to Systems Analysis and Design	Mar 22-24	Raleigh, NC	North Carolina State University Data Processing Education Program P.O. Box 5125 Raleigh, NC 27650 (919) 737-2261